SIMRAD

PRO SERIES

ARGUS RADAR SCANNER CE

Technical User Manual

ENGLISH

ARGUS RADAR

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RECORD OF CHANGES

RCS CODE/REV. INDEX	DATE	CHANGE PURPOSE	CHANGE REQUESTED BY
Revision 1	February 2015	First emission	CR 64773

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WARNINGS

Warning information

The following warnings appear in the text of this technical manual, and are repeated here for emphasis. For correct operation, please, read this instruction manual carefully, before operating the equipment.

WARNING

IN THIS OPERATING OR MAINTENANCE MANUAL, STATEMENTS THAT ARE NOT STRICTLY FOLLOWED, MAY RESULT IN INJURY OR DEATH PERSONNEL.

WARNING

IN THIS OPERATING OR MAINTENANCE MANUAL, STATEMENTS THAT ARE NOT STRICTLY FOLLOWED, MAY RESULT IN DESTRUCTION OR DAMAGE TO UNIT OR LOSS OF EMISSION EFFECTIVENESS.

WARNING

“WARNING” SHOW AND PRECEDE ESSENTIAL MAINTENANCE PROCEDURES, CONDITION AND STATEMENT WHICH MUST BE HIGHLIGHTED.

WARNING

USE EXTREME CARE WHEN WORKING ON THE UNIT ONCE THE COVER HAS BEEN OPENED. THE MAGNETRON OPERATES AT HIGH VOLTAGES THAT MAY CAUSE FATAL INJURIES.

WARNING

ON THE ELECTRIC SWITCHBOARD, SET TO OFF THE POWER BREAKER DEDICATED TO THE PRESENT EQUIPMENT AND HANG TO IT A PLACARD READING: “WORK IN PROGRESS - DO NOT SWITCH ON”.

WARNING

SET MAIN LINE BREAKER TO OFF BEFORE REPLACING ANY FUSE. FUSES ARE UNDER VO LTAGE LEVELS WHICH MAY PROVE FATAL.

Safety precautions

Safety precautions described in this paragraph are applicable to SRT X-BAND RADAR SYSTEM. The following are general safety precautions that are not related to any specific procedure and therefore do not appear elsewhere in this technical manual. These are recommended precautions that personnel must understand and apply during most phases of operation and maintenance.

You are obliged to read these operating instructions prior to operation and to adhere to the operating instructions in operation in order to prevent possible danger. Prevention of danger includes that operator personnel are trained and authorised for safe operation of the equipment. We assume no liability for damage due to improper operation which could have been prevented.

The system must only be operated by persons who have passed the relevant mandatory training on the respective systems and applications. Only reading these operating instructions cannot replace such training. Persons authorised to operate the system are specially instructed and trained from Consilium Italy. Persons authorised to carry out cleaning, maintenance, and troubleshooting are the specially trained and skilled personnel of the user. Persons operating or servicing the SRT X-BAND RADAR SYSTEM must be familiar with the general safety regulations and specific safety systems and they must have passed all required training and must have read the relevant operating instructions and manuals before starting work.

Have these operating instructions always at hand on location. Ensure that copies are available at all relevant operator. Operating personnel must at all times follow all safety regulations.

During normal operation (front cover closed), the unit can be quickly disconnected from the main power line, turning OFF the relevant circuit breaker located on the electric switchboard.

During maintenance (front cover opened), it is possible to turn on the unit, by linking P1 on SRT POWER Board (see figure 9.10, pos. 1). This link forces the unit main power to be ON. During normal operation P1 on SRT POWER Board must be set OPEN.

Do not replace components or make adjustments inside the unit when the voltage supply turned ON. Always remove power and discharge to ground a circuit before touching it. Under no circumstances should any person initiate servicing or repairing the unit except in the presence of someone qualified operator.

Ensure unobstructed access to all operator panels, controls, and relevant switchgear cabinets in order to enable instant response to alarms.

Whenever it is necessary to disconnect the waveguide from a radar transmitter for maintenance purpose, the transmitter output should be terminated with a matched load. If this is not possible, care should be taken, to don't stand in front of an open-ended waveguide from which power is being radiated.

NEVER look down a waveguide from which power is being radiated.

NOTE
Main power line is always present on terminal board and on fuses.

High voltage

SRT X-BAND RADAR SYSTEM transceiver requires usage of high voltage, which can cause serious injury, or even loss of life. Danger exists especially when units are opened exposing internal circuits, as when servicing the equipment. This equipment has been carefully designed to protect personnel from possible injury from high voltages.

As an additional safety measure, it is strongly recommended that safety switch always be opened when inspecting or servicing the equipment. Opening the safety switch provides a voltage reduction; anyway caution is always needed.

The manufacturer is not responsible for any injury or death connected with the use of this equipment, due to lack of caution or to improper use.

Appropriate actions must be taken before starting to work:

- Switch off the equipment; disconnect the equipment from the mains supply.
- Take precautions against inadvertent re-connection.
- To verify that circuits are dead and no voltage is present, perform the appropriate measurements (for example ground and short-circuit).

The dangerous voltages are no longer present. Mains switches are live even when the equipment is switched off.

Radio frequency

Harmful effects (particularly to the eyes), may be caused by exposure of any part of the human body to radio-frequency mean power densities. Hazard distances at which power densities of 100 W/m², 50 W/m² and 10 W/m², for each type of unit used with the SRT X-BAND RADAR SYSTEM, are given in the following table:

CONFIGURATION	Distance to 100 W/ m² point [m]	Distance to 50 W/ m² point [m]	Distance to 10 W/ m² point [m]
25 kW Transceiver + 12'X Band Antenna (ANT12X-001)	-	0,05	0,9

The system is however designed too always disable the microwave radiation when the antenna is not rotating.

X-Ray radiation

This unit does not generate X-RAY radiation.

Interlock

Transceiver have one type of interlock with specific functions: proscribes the transmission and the magnetron feed.

Safety switch

The pedestals have also been prepared for the installation of an external safety switch, which can be mounted on, or near the platform. This switch removes the power from the Pedestal eliminating the possibility of accidental operation during servicing and also causes disabling of transmission.

The safety switch, disable the Antenna movement during maintenance operations and avoids high voltage damage.

Always turn the safety switch off, whenever advised in this manual (for instance, before performing any maintenance or installation procedure). Ignoring safety switch operation may produce hazard of electrocution as well as other severe injuries.

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CHAPTER 1
DESCRIPTIONS AND MAIN CHARACTERISTICS

1.1 Introduction

1.1.1 Manual applicability

The present technical manual provides information, data, and procedures relevant to general description, operation, functional description, scheduled maintenance, troubleshooting, corrective maintenance and replaceable parts list of the SRT X-BAND RADAR SYSTEMS consisting of 25 kW pedestal and 12 feet antenna.

For brevity of description, reference to the equipment in this manual, can also be made by means of the Manufacturer code name: MAN-SRXUP-003

SRT X-BAND RADAR SYSTEMS with 25 kW Pedestal with 12 Feet Antenna (see figure 9.4).

The contents of the present technical manual are arranged in 10 Chapters as follows:

	WARNING
Chapter 1	DESCRIPTIONS AND MAIN CHARACTERISTICS
Chapter 2	OPERATION
Chapter 3	FUNCTIONAL DESCRIPTION
Chapter 4	PREVENTIVE MAINTENANCE
Chapter 5	TROUBLESHOOTING
Chapter 6	CORRECTIVE MAINTENANCE
Chapter 7	PART LIST
Chapter 8	INSTALLATION
Chapter 9	FIGURES

1.1.2 SRT X-BAND RADAR SYSTEM purpose

The SRT X-BAND RADAR SYSTEM, when connected to a Display Unit (not described in this manual), performs the following functions:

- It receives the radar controls from the Display Unit connected to the equipment.
- It generates and receives the RF pulses.
- It processes the RF pulses.
- It sends the radar data and controls to the Display Unit.

The equipment’s power supply, 48 VDC is given by the Display Unit or from the SRT Adapter

1.2 List of abbreviation

Very often navigation related information's are presented using the standard terms or abbreviations. Measurement abbreviations according to MIL STD-12; other terms and abbreviations used in the present manual are listed in table 1.1.

ABBREV.	TERMINOLOGY
AC	Alternating current
ACP	Azimuth clock pulse
ARP	Antenna Reference
AZ	Antenna azimuth pulse
dB	Decibel
dBm	Decibel refered to 1 milli-Watt
DC	Direct current
DCORE	Display Core Unit
GND	Ground
HL	Heading line
HV	High voltage
HSC	Higt speed craft
ID	Identification
IF	Intermediate frequency
IN	Input
IP	International protection degree
I/O	Input/Output
kW	Kilo watt
LED	Light emitting diode
LNFE	Low noise front end
LPA	Long pulse adjustment
LV	Low voltage
Mag	Magnetron
MDS	Minimum detectable signal
min	Minimum / Minutes
MHz	Mega Hertz
MOS	Metal oxide semi-conductor

ABBREV.	TERMINOLOGY
MPA	Medium pulse adjustment
NC	Normally Closed
NMEA	National marine electronics association
NO	Normally Opened
N/A	Not applicable
OUT	Output
PM	Performance Monitor
PRF	Pulse Repetition Frequency
PS	Power supply
PWON	Power on
PWR	Power
P/N	Part number
RDC	Radar display console
RF	Radio frequency
RPM	Revolution per minute
RX	Receiver
SP	Spare Part
SPA	Short pulse adjustment
SRT	Small radar transceiver
STC	Sensitivity time control
TTL	Transistor-transistor logic
TX	Transmission
TXRX	Transceiver
VCO	Voltage controlled oscillator
VD	Video
VEL	Velocity
WG	Waveguide

Table 1.1 – List of abbreviation

1.3 Configurations table

PEDESTAL	ANTENNA	TRANSCEIVER	OUTPUT POWER	ROTATIONAL SPEED
SRT/25-002	ANT12X-001	Included in Pedestal	25 KW	Standard (20RPM)

Table 1.2 – Configurations table

1.4 Physical description

The SRT 25 kW X-Band Radar System is composed of (see figure 9.2):

- The Antenna 12 feet (pos. 3);
- The Pedestal (pos. 1);
- The Encoder (see figure 9.30, pos.2);
- Optional equipment: Heater, SRT Adapter Box (see figure 9.36).

All Units are designed for maximum resistance to the severe environmental conditions in which they have to operate.

DESCRIPTION	CONFIGURATION	CODE	WIDTH (mm)	HEIGHT (mm)	DEPTH (mm)	WEIGHT (Kg)
SRT 25 kW X-Band Radar System	Upmast	SRT/25-002	**364***	**391***	**546**	**35***
	with 12´ Antenna	ANT12X-001	**3618**	**466**		**49**

- (*) Without Antenna

Table 1.3 – Physical description

1.4.1 Antenna

The antenna consists of:

- a side feeded slotted waveguide of 12 feet length,
- a waveguide feeding the slotted waveguide from the rotary joint including a turnaround part. The connection to the rotary joint is through a choke flange without screws.
- a polarisator to radiate only in horizontal polarization.
- an antenna horn consisting of upper and lower side to form the vertical beam.
- a plastic external cover for weather protection.

The antenna (see figure 9.2, pos. 3) is mounted on the pedestal support (pos. 2) by the antenna support structure with 4 screws. This support structure makes the antenna more rigid against wind and vibration.

1.4.2 Pedestal

The Pedestal is composed of a metal cabinet (see figure 9.3, pos. 1), made of Aluminum, treated with anticorrosive paint in order to be saline atmosphere resistant. The cabinet is

provided with a cover (see figure 9.4, pos. 2) fixed to the cabinet by four screw (pos. 1); the cover can be opened to allow an easy access to the internal components.

In that part of the cabinet, which is on the same side as the cover hinge (se figure 9.3, pos. 2), the following items are located:

- the screw for the grounding connection of the Unit to the ship structure (pos. 4);
- the main connector (pos. 3) for the connecting cable with the Display Unit used also for the power supply.

In Upmast configuration, when the cover is open, it is possible to access the following internal units (see figure 9.4):

- Connecting Terminal Board;
- Electronics Rack (pos. 4);
- Brushless Motor Controller board (pos. 5);
- Motor Unit (pos. 6);
- RF Head (see figure 9.28).

1.4.2.1 Main connector

The Main Connector (see figure 9.3, pos. 3), is mounted at the bottom of the Pedestal cabinet (pos. 1). This main connector allows the connection between the Display Unit (or the optional SRT Adapter Box), and the Pedestal Unit (including the Motor Unit and Electronics Rack).

On the Main Connector the following signals can be located:

- Combined Video;
- Power supply;
- Safety Switch.

1.4.2.2 SRT electronic parts

The SRT X-BAND RADAR SYSTEM contains high speed electronic circuits, which allow to the RF HEAD, transmission, reception and processing the RF echoes.

Tables 1.4, 1.5 and 1.6 lists the main assemblies composing the unit and their position inside the unit.

DESCRIPTION	POSITION
RF HEAD	Figure 9.4, pos. 7
Electronic Rack	Figure 9.4, pos. 4
Encoder	Figure 9.30, pos. 2
Brushless motor controller Board	Figure 9.4, pos. 5
Brushless motor	Figure 9.4, pos. 6

Table 1.4 – SRT X-BAND 12 kW and 25 kW composition

DESCRIPTION	POSITION
Magnetron	Figure 9.27, pos. 1
Circulator	Figure 9.28, pos. 4
Limiter	Figure 9.28, pos. 2
RFAmplifier	Figure 9.28, pos. 1
Noise Diode	Figure 9.28, pos. 3
Power Diode	Figure 9.28, pos. 5

Table 1.5 – RF Head

DESCRIPTION	POSITION
SRT Control	Figure 9.6, pos. 2
SRT MOS	Figure 9.6, pos. 3
SRT Power	Figure 9.6, pos. 1

Table 1.6 – Electronics rack

The Electronics Rack is connected to:

- the Encoder by a connector (see figure 9.30, pos. 2) on the SRT Control Board;
- the Brushless Motor Controller Board (see figure 9.4, pos. 5);
- the RF Head (pos. 7 and figure 9.28);
- the Display Unit, through the Main Connector (see figure 9.3, pos. 3).

1.4.2.3 Motoreducer assembly

The Motoreducer assembly is composed of (see figure 9.5):

- the Motor Unit (pos. 1) whose function is to provide the necessary power to produce the Antenna rotation;
- the Gearbox (pos. 2) whose function is to reduce the motor angular speed;
- the final gear (pos. 3) whose function is to transmit, through the rotating wheel, the motion, provided by the Gearbox, to the Antenna,
- the Encoder (see figure 9.30, pos. 2), whose function is is to increase the angular resolution of the azimuth and heading signal to 128 / 1024 / 4096 pulses for revolution.
- the Rotary Joint (see figure 9.31, pos. 1), whose function is to connect the Waveguide of the Antenna to the internal one;

The Motoreducer assembly is connected to the Brushless Controller by means of a cables provided with connectors for the Electric Motor supply.

1.5 Functional description

The SRT 25 kW X-BAND Radar System is divided mainly into Receiver and Transmitter sections, both connected to a solid state controlled modular RF HEAD.

The Transmitter generates the RF energy in the X-Band range and pulses modulated with a nominal peak power of 25 kW. The length and PRF of the pulses are in accordance with the

range scale selected on the Display Unit. The transmission pulses can be: Short, Medium and Long.

The Receiver enables reception of echoes and subsequent amplification in the RF Head (see figure 9.4, pos. 7).

The Electronics Rack unit also includes the circuits to generate the voltage required for its operation (see figure 9.9).

The function of the Antenna unit is to:

1. Transmit the R.F: pulses within the specified vertical and horizontal lobes with horizontal polarization.
2. Receive the reflected R.F. echo signals and forward them towards the RF HEAD.

1.6 Technical characteristics

In the following tables are reported the technical characteristics for the SRT X-BAND RADAR SYSTEM 25 kW pedestal and 12 feet antenna.

GENERAL DESCRIPTION
In this configuration a sturdy and splash proof antenna pedestal houses the following sub-assemblies: - Built-in, X band, solid state controlled Transceiver; - Transceiver DC Power Supply and external AC/DC converter box; - Antenna Motoreducer assembly; - High performance plastic gear wheel; - RF rotary joint; - Encoder 4096 pulses. - The antenna is an End Fed Slotted Waveguide type. The above compact arrangement allows a direct coupling between Transceiver and rotary joint, thus simplifying the installation work and significantly reducing the RF losses normally accepted when the Transceiver is installed into a separate cabinet in “down-mast” position. The interface with the radar console is through a single connector and it is not necessary to open the transceiver casting during installation. Every analog adjustment is made remotely from the SELUX console. The pedestal with built-in 25 kW transceiver supports 12´ antenna. Both Transceiver and motor driver are fed by a 48 VDC supply, an external transformer is required for 115/220 VAC 50/60 Hz power supply. The Transceiver has new compact electronics with a high integration level derived from a well-tested design. Main features: - Modular and solid state construction; - Electronic Modulator based on MOSFET technology; - Long life 3rd/4rth generation magnetron (25 KW); - Low Noise Amplifier providing a reduced overall Noise Figure (4.0 dB nominal); - Microcomputer controlled operations; - Serial link with telemetry and remote control for adjustments; - Built-in test facilities for power supply and modulator parameters; - PRF jittering removing any possible ambiguity due to multiple-time-around echoes; - Two different Sectors Blanking to be set at time of installation; - Performance Monitor; - Rotation: 20 RPM.

(continue)

ANTENNA & PEDESTAL TECHNICAL SPECIFICATION	
Characteristics	**Values**
Antenna model	12X
Antenna Unit Type I/N	ANT12X-001
Driver & Transceiver I/N:	SRT/12-002 SRT/25-002
Antenna type	End-fed-slotted wave guide
Antenna length (inch / mm.)	12' / 3618
Antenna swing circle (/ mm.)	3618
Frequency (MHz)	9325-9425
Polarization	Horizontal
Gain (dB)	32,5
Horizontal beam width at -3 dB	0,7°
Vertical beam width at -3 dB	22°
Horizontal side lobes ('dB):	
- within 10°	- 26
- outside 10°	- 30
VSWR	Better than 1.20
PPR	4096
Nominal Rotation speed (RPM)	> 20
Nominal Wind resistance (KT)	100

(continue)

X-BAND TRANSCEIVER TECHNICAL SPECIFICATION	
Characteristics	**Values**
Transceiver I/N:	SRT/25-002
Operating frequency (MHz):	9410 ± 30 (X Band)
Pulse length (nsec.):	60 - 250 - 800
PRF (Hz):	3000-1500-750
Modulator:	MOSFET Solid state
IF amplifier:	Logarithmic
IF dynamic (dB)	100 (+30 pre STC)
IF center frequency (MHz)	60
IF bandwidth (MHz): - short pulse - medium pulse - long pulse	 20 4,8 1,5
Overall noise figure (nominal dB)	≤ 5
MDS on long pulse (dBm)	≤ -110
- Overall at receiver level	≤ -100
- At IF level	≤ -110
ENVIRONMENTAL FEATURES	
Operating temperature	-25°C / +55°C As in IEC 60945
Storage temperature	-25°C / +70°C As in IEC 60945
Relative humidity	Up to 95% at +40° As for IEC 60945
Vibrations	As for IEC 60945
Protection grade	IP 66
Wind resistance (KT)	100
DIMENSIONS (mm)	
Width	364
Depth	546
Height	391
WEIGHT (kg)	
Pedestal with Transceiver	35
REQUIRED POWER SUPPLY	
Standard configuration	24 VDC or 115/220 VAC
Power consumption:	Ca 350 W Peak at maximum wind load
OPTIONS	
Different PRF set	Upon Customer request
Heaters	For very cold environments (< -25° C)

Table 1.7 – SRT X-BAND RADAR SYSTEM technical characteristics

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CHAPTER 2
OPERATION

2.1 Introduction

This chapter provides operating instructions, information and procedures required in order to enable operating personnel to efficiently and effectively operate the SRT X-BAND RADAR SYSTEM.

The unit does not require personnel on steady watch conditions, but requires general monitoring during normal operating situations.

2.2 Controls and indicators

The various types of LED visible by the operator at the moment of disassembling the front panel of SRT X-BAND RADAR SYSTEM are listed in this paragraph. The tables below show in order:

- board in which they are positioned;
- board part number;
- LED code;
- LED coloration;
- type of frequency illumination;
- brief description of their function.

> ***NOTE***
>
> *Regarding the location of the LEDs, Test Points and Jumpers that will be described, refer to the electrical diagrams and images shown in chapter 9.*

BOARD	PART NUMBER	CODE	LED	FREQUENCY	FUNCTION
SRT CONTROL board	973281A2	D3	Green	Gradually slow flashing	Transmitter is OK
		D23	Red	On/off normal	Transceiver is transmitting
** Combined video or serial configurations is determined by settings the Jump J10.*					

*Table 2.1 – Behaviour LEDs in serial configuration**

BOARD	PART NUMBER	CODE	LED	FREQUENCY	FUNCTION
SRT CONTROL board	973281A2	D3	Green	Gradually slow flashing	Transmitter is OK
			Blue	Off	Refer to paragraph 2.3

(continue)

SRT CONTROL board	973281A2	D23	Green	Off	Transceiver is not trasmitting data to the console
		D26	Green	Fixed	If Power Supply on SRT PWR-DC board > 42V
			Red	Off	If power supply on SRT PWR-DC board < 38V
** Combined video or serial configurations is determined by settings the Jump J10.*					

*Table 2.2 – Behaviour LEDs in combined video configuration**

BOARD	PART NUMBER	CODE	LED	FREQUENCY	FUNCTION
SRT DOWN ADAPTER board	973501A1	D4	Green	ON	Presence of 5 V supply feed.
			-	OFF	Not presence of 5 V supply feed.
	973501A1	D3	Red	ON	Reports enabling the antenna rotation.
			-	OFF	Do not enable the antenna rotation.

Table 2.3 – Behaviour LEDs on SRT DOWN ADAPTER board

FAIL	CAUSE
Mag heater fail	Vfil < 4.5V and > 8V
24 VCO fail	24V (voltage) < 18V or > 30 V
+15 fail	15V (voltage) < 14 V or > 16 V
Rx fail	If no packet has been received after 5 seconds
CRC fail	If there is a CRC failure in receiving a packet
Interlock open	If the interlock is open
Safety switch open	If the safety switch is open
+24 fail	If power supply of SRT is 24V < 18 V
+48 fail	If power supply of SRT is 48V < 40 V
Front end fail	If monitor voltage is < 40 mV or > 90 mV

Table 2.4 – LED D3 SRT ADAPTER board status: blinking red

BOARD	PART NUMBER	CODE	LED	FREQUENCY	FUNCTION
SRT POWER board	973261A3	DL1	Green	ON	It indicates the presence of the +24VDC power supply
		DL2	Green	ON	It indicates the presence of the +5V
		DL3	Red	ON	It indicates the presence of High Voltage

Table 2.5 – Behaviour LEDs on SRT POWER board

BOARD	PART NUMBER	CODE	LED	FREQUENCY	FUNCTION
Brushless Motor Controller board	304427A1	DL1	Green	ON	It indicates the presence of the +50 VDC power supply
		DL2	Red	ON	Motor in OFF or controller in protection
				OFF	motor in rotation

Table 2.6 – Behaviour LEDs on Brushless Motor Controller board

2.3 Semi-operative controls

Some semi-automatic controls, test points and jumpers are listed in this paragraph; useful to the operator for carry immediate checks of the machine and verify the correct functioning. Opening the transceiver front panel, there is the possibility of carrying out certain types of checks. These controls are summarized in the tables below and subdivided on the basis of the boards on which they are located.

NOTE

When SRT X-BAND RADAR SYSTEM front cover is opened, interlock is "OPEN" and interrupts the transmission and disables the SRT MOS board high voltage requires.

JUMPER LIST		
NAME	**OPEN**	**CLOSE**
J7	Serial mode transmission	Video combined mode transmission
J8*	Warmup counts 3 minutes before transmission	Warmup counts 0 minutes
J10	Is not possible load the boot processor	Is possible load the boot processor
J21	When is two noise diodes	When is one noise diode

Table 2.7 – SRT CONTROL board jumpers

* This jumper must always be open, to allow the three-minute warmup. This time allows the magnetron to come up to temperature. The transaction's closing Jumper J8 can be performed only by a technician.

For this following table refer to figure 9.17.

TEST POINT		DESCRIPTION	TEST POINT		DESCRIPTION
TP1	HVON	High voltage ON	TP16	LINE	Input voltage sense
TP2	+5V	Power Supply from SRT PWR-DC board	TP17	TXCOMB	Tx data signal in combined mode
TP3	PWON OUT	Test signal configurable	TP18	GND	Ground
TP5	+24V	Power Supply from SRT PWR-DC board	TP19	VDIN	Video input from RF Detector board
TP6	VCO	IF tunable oscillator voltage	TP20	VDOUT	Video output
TP7	-15V	Power Supply from SRT PWR-DC board	TP21	RX	Serial data reception
TP8	+15V	Power Supply from SRT PWR-DC board	TP22	TX	Serial data transmission
TP9	PWON OUT	24 V needed to switch on the system	TP23	AZ OUT	antenna azimuth output
TP10	VFIL	Magnetron heater voltage	TP24	HL OUT	Antenna heading line output
TP11	-5V	Power Supply from SRT PWR-DC board	TP25	TRPUSH	Modulator trigger push control
TP12	PREST C	Short range fixed attenuation	TP26	TRPULL	Modulator trigger pull control
TP13	ANTS	Antenna start output	TP27	MOTOR CURRENT	Motor current sense
TP14	TROUT	Trigger output	TP28	GND	Ground
TP15	RXCOM B	Rx data signal in combined mode	TP29	GND	Ground

Table 2.8 – SRT CONTROL board test point

POSITION	CODE	TYPE	FUNCTION
SRT X-BAND RADAR SYSTEM	S1	Interlock	TXRX cover interlock switch for disabling the high voltage power and interrupt the transmission.
SRT CONTROL board	S1	10 Position rotary switch	It selects the TXRX unit operation mode as follow (see figure 9.11):

POS.	FUNCTION
0	SRT under external control 1.
1	SRT under external control 2.
2	SRT in local stand-by.

SRT CONTROL board	S1	10 Position rotary switch	3	The SRT works independently from the console with short pulses.
			4	The SRT works independently from the console with medium pulses.
			5	The SRT works independently from the console with long pulses.
			6	SRT in local with long pulse and performance monitor with auto tuning and antenna rotation.
			7	Standby mode.
			8	Standby mode.
			9	Service mode long pulse. Performance monitor ON. Autotune. Antenna rotating.

Table 2.9 – SRT X-BAND RADAR SYSTEM semi-operative controls

2.4 I/O requirements

In this paragraph are reported the minimum and maximum values of input and output related to the SRT X-BAND RADAR SYSTEM. The tables has been divided into four columns of which:

- **SIGNAL NAME**: Type of Signal analyzed;
- **TYPE**: Identifies the type of signal being analyzed;
- **DESCRIPTION TYPE**: Reference values that should appear during the measurement (in case of correct operation).

SIGNAL NAME	TYPE	DESCRIPTION TYPE
VDOUT	Polarity	Positive
	Amplitude	From -2 to +2 V
	Load	Terminated 75 Ω (always present on Board)
	Bandwidth	2 - 5 - 24 MHz (-3 db)
	DC level	0 V
TROUT	Polarity	Positive
	Amplitude	From 0 to 15 V
	Load	Terminated 75 Ω (always present on Board)
	PRF	3000 – 1500 – 750 Hz
	Pulse width	1,28 µS (min.)
	Functionality	Trigger point at low-to-high transition
	Rise Time	≤ 180ns (10-90 %)
Programmable pretrigger output: PTROUT	Polarity	Positive
	Amplitude	TTL @ 50 Ω / @ 75 Ω 0 ÷ 15v @ ∞ (high impedence)
	Load	50 Ω to ∞
	Pulse width	640 ÷ 10240 ns
	Pulse advance	0 ÷ 40 µs
	Rise Time	≤ 180ns (10-90 %)

(continue)

Serial interface: SEROUT / TX ± SERIN	Signal Standard	RS232 terminated 3 KΩ RS422 terminated 120 Ω (selectable) Baud rate 4800
Position data: ACP ACPIN	Amplitude	4 to 11 V high level 128/1024/4096 pulses per antenna revolution
	Load	Load: ≥ 2 kΩ
	Pulse width	> 80 µs
Antenna reference: ARP ARPIN	Amplitude	4 to 11 V high level One pulse for revolution
	Load	≥ 2 KΩ
	Pulse width	> 80 µs
Antenna start: ANTS	Load	Open collector output 100mA Antenna rotating when ANTS is shorted to ground
Position data: UA1 / nUA1	Amplitude	RS 422 balanced output
Antenna reference: UA0 / nUAO	Amplitude	RS 422 balanced output
Power on: PWON	Amplitude	From 3 V to 30 V to power up transceiver electronics
Antenna speed control: SPD	Amplitude:	From 2V to 5V

Table 2.10 – I/O Requirements

2.5 NMEA Transfer Protocol

2.5.1 Abbreviations

RDC - Radar Display Console
TXRX - Transceiver (TX/RX)
CRC - Checksum Field

Field type	*Symbol*	*Definition*
Status	A	A = Yes, data valid, warning flag clear. V = No, data invalid, warning flag set.
Variable Numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal fraction are optional if full resolution is not required (example: 73.10 = 73.1 = 073.1 = 73).
Fixed HEX field	hh-	Fixed length HEX number only, MSB on the left.
Variable text	c—c	Variable length valid character field.
Fixed alpha field	aa-	Fixed length field of upper-case or lower-case alpha characters.
Fixed number field	xx-	Fixed length field of numeric characters.
Fixed text field	cc-	Fixed length of valid characters.

NOTE [1] Spaces shall only be used in variable text fields.
NOTE [2] A negative SIGN "-" (HEX 2D) is the first character in a field if the value is negative. When used, this increases the specified size of fixed length fields by one. The sign is omitted if the value is positive.

2.5.2 Data Transmission from RDC to TXRX

OPERATIONAL CONTROL SENTENCE

$PCO2,x,a,aa,aaa,a,a,a,a,hh,a*hh<CR><LF>

- MGN Heater: **W** = warm, **C** = cold else **NULL (AUTO)**
- Tuning adjust (min 00H, max FFH). If Automatic don't care.
- **M** = Manual Tuning, **A** = Automatic Tuning
- **V** = Video test else NULL (OFF)
- **P** = Performance Monitor ON else NULL (OFF)
- **J** = Jitter ON else NULL (OFF)
- **Rxx** = Antenna Rotating ON with xx RPM (01 ÷ 80) else NULL (OFF)
- Transceiver control (³)
- **M** = Request Master of Transceiver, **S** = Slave (²)
- Selected Transceiver Number (¹)

Notes:

(¹) Transceiver Number: 1, 2, 3, 4 **(SPARE in stand alone TXRX)**

(²) Master/Slave request **(SPARE in stand alone TXRX and single equipments)**

(³) Transceiver control:

Field type	*Field Descriptions*
SB	Stand By
SH	Short pulse, High frequency
SM	Short pulse, Medium frequency
SL	Short pulse, Low frequency
MM	Medium pulse, Medium frequency
ML	Medium pulse, Low frequency
LL	Long pulse, Low frequency

SECTOR BLANKING SENTENCE

$PSE2,a,x.x,x.x,x.x,x.x*hh<CR><LF>

- End Sector 2
- Start Sector 2
- End Sector 1 (1)
- Start Sector 1
- **D** = Sector Blanking Values, **R** = Sector Blanking Request (2)

Notes:

(1) Start & End Sector units are degree integer value. Es: 123 - 71
This value will be rounded depending from the position sensor used

(2) If Sector Blanking Request, don't care

NEW SECTOR BLANKING SENTENCE

$PSE3,a,x.x,x.x*hh<CR><LF>

- End Sector 1 (1)
- Start Sector 1
- **R** = Sector Blanking Request (2)
  - **1** = Value of Sector one
  - **2** = Value of Sector two
  - **3** = Value of Sector tree
  - **4** = Value of Sector four

Notes:

(1) Start & End Sector units are degree integer value. Es: 123 - 71
This value will be rounded depending from the position sensor used

(2) If Sector Blanking Request, don't care of data

TIMERS INITIALIZATION

$PTIM,x,x,x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>

- Timer M-Pulse Low Freq.
- Timer S-Pulse Low Freq.
- Timer S-Pulse Medium Freq.
- Timer L-Pulse Low Freq. (²)
- Timer M-Pulse Medium Freq.
- Timer S-Pulse High Freq.
- Timer Standby
- Status 3
- Status 2
- Status 1 (¹)

Notes:

(¹) Command 1: **1** = Request for transmission of actual values
2 = Initialization of values .
3 = Reset of values.

Command 2: Spare

Command 3: Spare

(²) Timers : Integer value to pre-set the operated time. LSB is equal to 1 hour.

If **Command 1 = 1 or Command 1 = 3** don't care.

DIGITAL POTENTIOMETERS CONTROL

$PDPC,a,x,x*hh<CR><LF>

- **R** = potentiometer value Request, **F** = potentiometer Factory preset else NULL (¹)
  A = auto adjust (°)
- Potentiometer ID (²)
- Potentiometer increment signed value (³)

Notes:

(¹) Factory preset is available for latest TX/RX versions.

(²) Pot. ID

#Potentiometer to be upgraded:

0 PRE-STC AMPLITUDE
1 PRE-STC SLOPE
2 P.M. OPEN
3 P.M. DISTANCE (Power Level)
4 TUNING INDICATION
5 TUNE OFFSET
6 NOISE DIODE CURRENT

(³) Increment or decrement to apply (range ±7). **(NEVER SEND 0)**

(°) If "A" with pot id, adjust only the correspondent Pot. (not yet).
If "A" without pot id (,,), adjust all the auto adjustable (Tune offset for now).

Sentence should be sent under operator request only. Application of value is immediate but storage of this one (not volatile memory) will take place after 20 seconds from last change i.e. from last **DPC** sentence reception.

AUTO CALIBRATION OF ANTENNA SPEED

$PSPD,a,xx,xx,xx*hh<CR><LF>

- value in rpm of fast antenna speed
- value in rpm of medium antenna speed
- value in rpm of slow antenna speed
- **R** = value Request, **F** = Factory preset (1), **A** = auto adjust (2), **M** = maximum speed else NULL

The values accepted are from 10 to 80 rpm.

Notes:
(1) Factory pre-set is available for latest TX/RX versions.
(2) Auto adjust process take a lot of time

Sentence should be sent under operator request only. Application of value is immediate but storage of this one (not volatile memory) will take place after 20 seconds from last change.

TRIGGER/PRETRIGGER DELAY AND PRETRIGGER LENGTH

$PDLY,xx,xx,xx*hh<CR><LF>

- xx — Trigger Advance Delay in 20ns units. Max value is 127 (2.56 usec)
- xx — Pretrigger length in 10ns units. Max value is 511 (5.12 usec). Min. 48 (480ns)
- xx — -1 to request values back. Pretrigger Advance Delay in 20ns units.

Trigger advance delay. A delay is inserted between trigger and video, delaying the pulse transmission. Max delay 2047 units (40.96 usec), Minimum Delay 0.
All numbers are positive starting from 0.

CONFIGURATION SET

$PCFG,x,x,x,xxxx,h,,a,h,hhh*hh<CR><LF>

- Optional parameters. 12 bits in hex format ([6])
- Configuration. 4 bits in hex format.([5])
- Performance monitor available.([4])
- Short Pulse Set ([3])
- Antenna PPR ([1])
- Magnetron type ([2])
- PRF sets selection (from 0 to 3) ([7])
- R = request of status, S = save potentiometers as factory default

Notes:

([1]) Set the number of antenna PPR, 4 digits zero padded: (0128, 0132, 1024, 4096)

([2]) Magnetron Type :

Magnetron type Code	Magnetron type Model
0	MG5494
1	M1492
2	MG5424/MG5230T/MG5231T/MG5222/MG5089T
3	MG4010
4	M1475A
5	M1302L/M1555
6	MSF1425A/MAF1565
7	M1311L
8	MG5223
9	M1458A
10	M1568A

([7]) PRF Sets value used are 0 and 1.

	PRF Sets value 0		PRF Sets value 1	
Pulse	Remote 0	Remote 1	Remote 0	Remote 1
Long	750	760	725	775
Medium	1500	1520	1450	1550
Short	3000	3040	2900	3100

([3]) Short Pulse width, from 0 to F (maximum) in 10 ns steps. This is the nominal trigger pull.

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*A*	*B*	*C*	*D*	*E*	*F*
40	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**105**	**110**	**115**

(4) Set the Performance Monitor Unit installation status, “P” = present, NULL not present.

(5) Main power status, Bit 0 set to 0 power supply at 24 volt
Bit 0 set to 1 power supply at 50 volt.
Bit 1 set to 1 HSC Antenna.
Bit 2 set to 1 Gear motor ratio 1:20.
Bit 3 set to 1 HL Falling front, 0 Rising front.

(6) TXRX Type, Bit 0 set to 0 for Speed Control, 1 for Antenna fixed speed
Brushless Controller Type, Bit 1 set to Speedmotion, 1 for BMD types

WARNING

HSC Antenna and Gear motor ratio 1:20 cannot be both active, a message with such configuration will be refused.

DATA REQUEST

$PREQ,x*hh<CR><LF>

└ Request/select a set of data

Request code	Data Description
0	Antenna speed/angle 128 values packed in 4 packets. Every number represents speed in rpm x 2 for every 360/128 ° aligned to HL. The speed is calculated in the last 16 scans.
1	Motor Torque/angle 128 values packed in 4 packets. Every number represents motor torque expressed in Nm at the antenna for every 360/128 ° aligned to HL. The torque is calculated in the last 16 scans.
2	Acceleration spectrogram for X axis, PCB Accelerometer. 64 values of acceleration with resolution 50/64 Hz, integrated in the last 60 seconds
3	Same of 2 for Y axis
4	Same of 2 for Z axis
5	Same of 2 for X axis, external accelerometer
6	Same of 5 for Y axis
7	Same of 5 for Z axis

2.5.3 Data Transmission from TXRX to RDC

STATUS SENTENCE 2

$PST2,x,a,aa,aaa,a,a,a,a,a,hh,a,a,,a*hh<CR><LF

- Protocol Version (Starting from A) **(4)**
- Empty Field
- MGN Heater: **W** = warm, **C** = cold else NULL (N.A.)
- **A** = Automatic Tuning ON else NULL (OFF)
- Manual Tuning Adjust. If Automatic NULL (Don't care)
- **P** = Performance Monitor Available else NULL (N.A.)
- **S** = Service Mode **A** = Auto Adjust. else NULL (OFF)
- **W** = Warm Up, **R** = Ready
- **X** = X-Band , **S** = S-Band Transceiver
- **J** = Jitter ON else NULL (OFF)
- **Rxx** = Antenna Rotating ON with xx RPM (01 ÷ 60) else NULL (OFF)
- Transceiver status (³)
- **M** = Acknowledge Master, **S** = Slave (²)
- Transceiver Number (¹)

Notes:

(¹) Transceiver Number: 1, 2, 3, 4 **(NULL in stand alone TXRX)**

(²) Master/Slave acknowledge **(NULL in stand alone TXRX)**

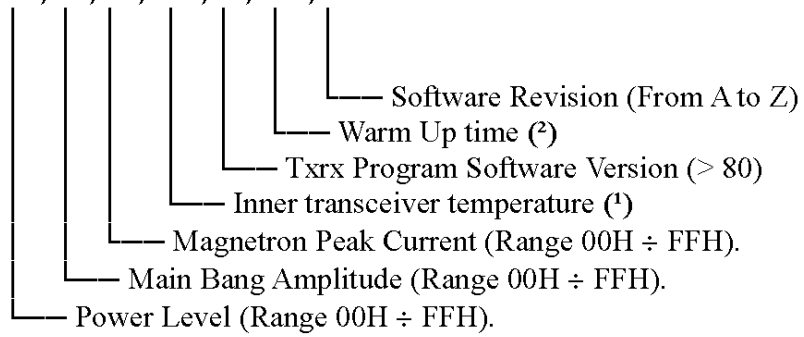
(⁴) to be used only for release a warning message.

(³) Transceiver status:

Field type	*Field Descriptions*
SB	Stand By
SH	Short pulse, High frequency
SM	Short pulse, Medium frequency
SL	Short pulse, Low frequency
MM	Medium pulse, Medium frequency
ML	Medium pulse, Low frequency
LL	Long pulse, Low frequency
SE	Short pulse, External trigger
ME	Medium pulse, External trigger
LE	Long pulse, External trigger

DATA SENTENCE

$PDAT,hh,hh,hh,xxx,xx,xxx,x*hh<CR><LF>


Software Revision (From A to Z)
Warm Up time (2)
Txrx Program Software Version (> 80)
Inner transceiver temperature (1)
Magnetron Peak Current (Range 00H ÷ FFH).
Main Bang Amplitude (Range 00H ÷ FFH).
Power Level (Range 00H ÷ FFH).

Notes:

(1) Transceiver temperature: From -99 to 99 Celsius degree (signed value).

(2) Warm Up time: calculated in seconds, when null becomes TXRX READY.

Value of **power level, main bang and magnetron peak current** during sector blanking are frozen.

TIMERS INFORMATION

$PTIM,c--c,x.x,x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a*hh<CR><LF>

- Timers validity: **A** = valid **V** = invalid
- System timer (4)
- Timer M-Pulse Low Freq.
- Timer S-Pulse Low Freq.
- Timer S-Pulse Medium Freq.
- Timer L-Pulse Low Freq. (3)
- Timer M-Pulse Medium Freq.
- Timer S-Pulse High Freq.
- Timer Standby
- Status 3
- Status 2 (2)
- Status 1 (1)

Notes:

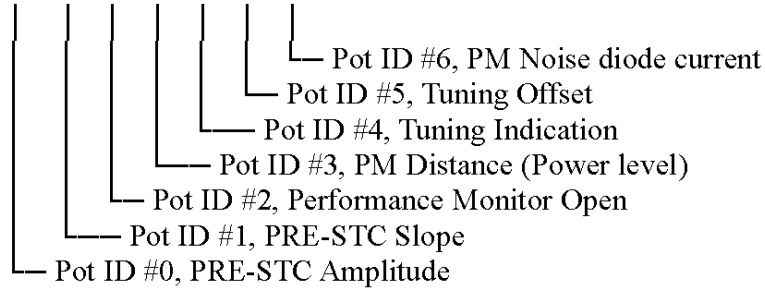
Status 1 (1) : Magnetron Type label
Status 2 (2) : Integer value indicating the magnetron end of life, from 0 to 999, > 100 mean end of life.
Status 3 : Spare

(3)Timers : Integer value indicating the operated time. LSB is equal to 1 hour.
(4)System : Integer value indicating lifetime of transceiver LSB is equal to 1 hour

When the trigger is sourced externally only the first three timers (SH/MM/LL) are incremented according the selected pulse. External PRF cannot be measured at this time so it is not fully correct from a lifetime perspective (es: external trigger PRF 750 Hz with short pulse).

DIGITAL POT. INFORMATION

$PDPI,xx,xx,xx,xx,xx,xx,xx*hh<CR><LF>


Pot ID #6, PM Noise diode current
Pot ID #5, Tuning Offset
Pot ID #4, Tuning Indication
Pot ID #3, PM Distance (Power level)
Pot ID #2, Performance Monitor Open
Pot ID #1, PRE-STC Slope
Pot ID #0, PRE-STC Amplitude

Notes:

Potentiometer decimal Value : Range 0 ÷ 99.

SECTOR BLANKING SENTENCE

$PSE2,,x.x,x.x,x.x,x.x*hh<CR><LF>

- End Sector 2
- Start Sector 2
- End Sector 1
- Start Sector 1

Notes:
Start & End Sector units are integer degree. Es: 90, 123, 1

NEW SECTOR BLANKING SENTENCE

$PSE3,a,x.x,x.x*hh<CR><LF>

- End Sector 1 (1)
- Start Sector 1
- **1** = Value of Sector one
  2 = Value of Sector two
  3 = Value of Sector tree
  4 = Value of Sector four

Notes:
(1) Start & End Sector units are degree integer value. Es: 123 - 71
This value will be rounded depending from the position sensor used

CONFIGURATION STATUS

$PCFG,,x,xx,xxxx,h,hhhh,a,h,hhhh*hh<CR><LF>

- PRF sets selection (from 0 to 3)
- Magnetron type (²)
- Antenna PPR (¹)
- Short Pulse Set (³)
- CRC program. 16 bits in hex format.(⁴)
- Performance monitor available.(⁵)
- Configuration. 4 bits in hex format.(⁶)
- Optional parameters. 12 bits in hex format (⁷)

Notes:

(¹) Set the number of antenna PPR, 4 digits zero padded: (0128, 0132, 1024, 4096)

(²) Magnetron Type :

Magnetron type Code	Magnetron type Model
0	MG5494
1	M1492
2	MG5424/MG5494/MG5230T/MG5231T/MG5222/MG5089T
3	MG4010
4	M1475A
5	M1302L/M1555
6	MSF1425A/MAF1565
7	M1311L
8	MG5223
9	M1458A
10	M1568A

(³) Short Pulse width, from 0 to F (maximum) in 5 ns steps. This is the nominal pulse length(ns)for the 25 KW X band transceiver.

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*A*	*B*	*C*	*D*	*E*	*F*
40	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**105**	**110**	**115**

(⁴) Show CRC program in hex value.

(⁵) Show the Performance Monitor Unit installation status, "P" = present, NULL not present.

(⁶) Main power status, Bit 0 set to 0 power supply at 24 volt
Bit 0 set to 1 power supply at 50 volt.
Bit 1 set to 1 HSC Antenna.
Bit 2 set to 1 Gear motor ratio 1:20.
Bit 3 set to 1 HL Falling front, 0 Rising front.

(⁷) TXRX Type, Bit 0 set to 0 for Speed Control, 1 for Antenna fixed speed
Brushless Controller Type, Bit 1 set to Speedmotion, 1 for BMD types

AUTO CALIBRATION OF ANTENNA SPEED

$PSPD,,xx,xx,xx*hh<CR><LF>

- Empty field
- value in rpm of slow antenna speed
- value in rpm of medium antenna speed
- value in rpm of fast antenna speed

NOT ACKNOWLEDGE COMMAND (NACK)

$PNAC,x,aaa,xx,xx*hh<CR><LF>

- Wrong field (³)
- Error Code (²)
- Refused Sentence (if recognized) (¹)
- Transceiver Number (as sentence **STS** or **NULL in stand alone TX/RX**)

Notes:

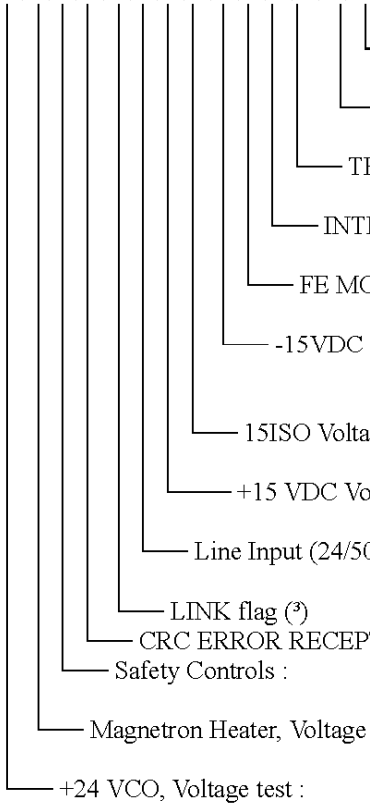
(¹) See list of accepted sentences
(²) Numeric value, from 0 to 99, command dependent (see list below)
(³) Field number. Incremental from 1 after sentence code.

Es. 1: **$PNAC,2,COP,01,05*hh<CR><LF>**
Meaning: feedback on error inside COP command for transceiver 2 through TXRX Interface, error type #01, field #05 (wrong JITTER field)

Es. 2: **$PNAC,,COP,01,37*hh<CR><LF>**
Meaning: same feedback error directly from TXRX

HEALTH SENTENCE 2

$PHT2,a,a,a,a,a,a,a,a,a,a,a,a,a,a*hh<CR><LF>



A = Matches with select pulse width
V = Pulse width invalid no transmission
A = Motor Current nominal
V = Motor Current Protection ant. STOP.
A = Temperature < 85 degree.
V = Temperature > 85 degree ant. STOP.
A = Transceiver safety door CLOSED
V = Transceiver safety door OPEN
A = Front End OK
V = Front End Fail
A = Test valid (value in range)
V = Test invalid (value out of range)

A = Test valid (value in range)
V = Test invalid (voltage out of range)
A = Test valid (value in range)
V = Test invalid (voltage out of range)
A = Test valid (value in range)
V = Test invalid (voltage out of range)

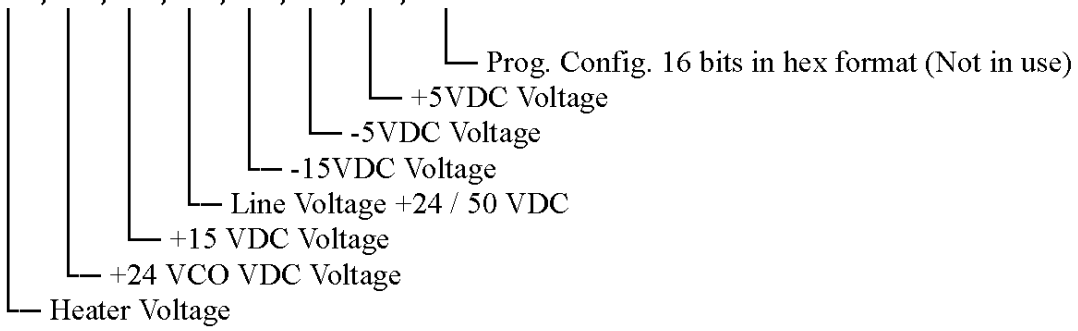
A = Test valid (safety sw. close)
V = Test invalid (safety sw. open) (1)
A = Test valid (value in range)
V = Test invalid (voltage out of range)
A = Test valid (value in range)
V = Test invalid (voltage out of range)

Notes:

LINK flag: Valid if Rx data are received.
Invalid if Rx data are NOT received. (time-out)
CRC ER: Invalid each time a crc error in Rx data will be found.

DATA SENTENCE 3

$PDT3,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,hhhh*hh<CR><LF>



Each value of voltage is integer and millivolt.

ACCELEROMETERS

$PACC,x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,*hh<CR><LF>

- Z Peak acceleration
- Y Peak acceleration
- X Peak acceleration
- Z Average
- Y Average
- X Average
- 0 = PCB accelerometer, 1 = External accelerometer

Peak/Average Acceleration is an integer value in mg (max 16000=16g) measured in one PACC transmission time.

REQUEST GENERIC DATA

$PRGD,a,a,a,hh*hh<CR><LF>

- Data packet in hex code 32 bytes MSB first
- sentence number
- total number of sentences
- Request code

PRETRIGGER/TRIGGER DELAY AND PRETRIGGER LENGTH

$PDLY,xx,xx,xx*hh<CR><LF>

- Trigger Advance Delay in 20ns units. Max value is 127 (2.56 usec)
- Pretrigger length in 10ns units. Max value is 511 (5.12 usec). Min. 48 (480ns)
- -1 to request values back. Pretrigger Advance Delay in 20ns units.

2.5.4 General Notes

Rates:

Data transmission rate to TXRX should be:
Sentence **CO2** 1 Hz normally, or when is necessary
Sentence **SE2/SE3** when is necessary upgrade Sector Blanking
Sentence **TIM** every time is necessary timers information or reset values
Sentence **DPC** every time is necessary digital potentiometer information or value upgrade
Sentence **CFG** only for first setup
Sentence **SPD** only for first setup and when the motor controller is changed

Rate shall be not faster than 50ms between two consecutive sentences.

Data transmission rate from **TXRX** are:
Sentence **ST2** 1 Hz normally
Sentence **DAT** connection depending : 1 Hz (Interfaces) or 150ms (TXRX).
Sentences **DPI, SE2** and **SE3** on request
Sentences **TIM,** on request and each 30 minutes of interval after power on.
Sentence **NAC** when necessary
Sentences **HT2** 1 Hz normally
Sentences **DT3** 1 Hz normally
Sentences **PACC** every 20 secs
Sentences **CFG** on request.
Sentences **SPD** on request.
Sentences **RGD** on request.

Error Code:

MESSAGE	ERROR CODE	MEANING
COP	00	CRC ERROR
CO2	01	Field not in compliance with specification
	02	Missing transceiver control
SE2	00	CRC ERROR
	01	Field not in compliance with specification
	02	Wrong sector value
SE3	00	CRC ERROR
	01	Field not in compliance with specification
	02	Wrong sector value
TIM	00	CRC ERROR
	01	Field not in compliance with specification
	02	Missing command type
	03	Initialization value outside limits
DPC	00	CRC ERROR
	01	Field not in compliance with specification
	02	Wrong potentiometer ID
	03	Potentiometer value outside limits
CFG	00	CRC ERROR
	01	Field not in compliance with specification
SPD	00	CRC ERROR
	01	Field not in compliance with specification
REQ	00	CRC ERROR
	01	Field not in compliance with specification
DLY	00	CRC ERROR
	01	Trigger field not in compliance with specification
	02	Pretrigger field not in compliance with specification

CHAPTER 3
FUNCTIONAL DESCRIPTION

3.1 Introduction

The present chapter provides the functional and detailed description of the main functions and operations performed by the SRT X-BAND RADAR SYSTEM.

Functional diagrams are used to depict signal processing whilst the text is used to support diagrams as necessary for explanation purposes.

Functional block diagrams show the development of a function from input to output in detail. Main assemblies and subassemblies (modules and cards) are shown and identified by code name and part number (P/N).

Hardware blocks are used in the signal paths to describe the processing functions performed. For a better understanding, the signal functions on circuit blocks are tagged by letters whose meanings are described in the list of abbreviations (see table 1.1).

Signal flows are mainly laid down from left to right and from top to bottom therefore subassemblies can be illustrated more than once to ensure logical signal flow. Signals, on functional block diagram, appear with their official code name as indicated on the manufacturer electric schematic diagrams and tabular interconnection lists.

Comments for explanation purpose on signal paths are within parenthesis; this sometimes identifies their operational accomplishment. Timing diagrams and word-code bit structure figures are also given as necessary for a better understanding of the described function. Logic terms and principles used in this technical manual comply with standard engineering practices.

Logic symbols (gates) are used, if they represent more appropriately, in a simplified form, the logic function performed even by complex parts of hardware. Where necessary, functional description of power supplies and minor assemblies are referred to schematic diagrams.

NOTE

The schematic block diagrams of Chapter 3 show all the functions that the boards' hardware could potentially support, while the related functional description refers only to the functions implemented in the present customized configuration.

3.2 Functional description

On the basis of the SRT X-BAND RARAR SYSTEM functional block diagram shown in figure 9.7, the equipment can be subdivided into the following main assemblies:

- Electronics Rack
- RF Head
- Brushless Motor Controller board
- Motor Unit

There are also a number of optional functions which are also described below, as:

- The SRT Adapter Box
- Heaters
- Encoder

3.2.1 Electronics rack

The Electronics Rack block diagram is shown in figure 9.7 and 9.8. Each block represents a functional area which is described in detail in the following function of the present chapter (paragraphs 3.3 through 3.7). The blocks indicated by dotted lines represent circuits assembled on the equipment chassis.

This is concerning all the blocks diagrams of this chapter.

Basically, the unit performs the following functions:

- it generates the power supply voltages required for the unit's functioning
- it generates the R.F. pulses which will be radiated by the Antenna; the pulses, in X-band wave length (9410 ±30 MHz) and with 25 kW peak nominal power, can be selected among the following:

Pulse Type	***Duration***	***PRF***
SHORT PULSE	nominal 60 ns	3000 Hz
MEDIUM PULSE	nominal 250 ns	1500 Hz
LONG PULSE	nominal 800 ns	750 Hz

- it receives the echoes reflected from targets and it converts and amplifies them
- it monitors the unit's correct operations

3.2.1.1 SRT POWER Board

The SRT POWER Board (see figure 9.11) is divided into 2 units, LVPS and HVPS; it generates all the voltage sources needed by the electronics rack from the original 50 VDC (40÷60).

The SRT POWER Board is equipped with protection circuits (see figure 9.12) to avoid wrong polarity connection, over current and over voltage spikes. A voltage sensor is connected with microprocessor interrupt request input to provide save state function in case of voltage fall under 40 VDC and to safely perform system shut down without data loss.

3.2.1.2 SRT POWER Board – Low Voltage Power Supply

The LVPS's function (see figure 9.13) is to generate the low DC voltages, necessary to supply the SRT electronic circuits. As input, the circuit receives the 50 VDC voltage. This voltage filtered and stabilized by suitable solid state components in order to get as output:

- +5 V, -5 V, +15 V, - 15 V, +15V Iso, +24V to supply all the other electronic circuits;
- VFIL, Magnetron Heather in accordance with selected Pulse and magnetron type.

3.2.1.3 SRT POWER Board – Low Voltage Power Supply

The H.V.P.S. Generator Circuit's function (see figure 9.14) is to generate the high voltage (700 V) necessary to pulse transformer and to the Magnetron for the transmission pulse generation. The signals used in this circuit are:

- 50 VDC (VMOD)
- HVON from Gate Array of SRT Control Board;
- LPA (Long Pulse Adjustment), MPA (Medium Pulse Adjustment) and SPA (Short Pulse Adjustment) from Gate Array of SRT Control Board;
- HVSTOP from SRT MOS board.

The H.V.P.S. starts functioning when the signal, output from the COMPARATOR, is active; the signal is active when:

- the signal HVON, from the Gate Array of SRT Control Board, is LOW; this signal is forced to high, inactive, when:
    - 3 min. period isn't yet passed since TXRX has been turned on
    - TXRX is in standby mode
    - safety switch or interlock is open.
    - +15V is ≤ 14V or ≥ 16V
    - VFil (6.3V) is ≤ 5V or ≥ 7V
- input voltage supply is over 40 VDC
- the signal HVSTOP is Low, which disables the functioning of the circuit when the +15 ISO voltage is absent.
- the HVPS Generator Circuit generates the correct high voltage value.

When the high voltage is generated, the COMPARATOR sends to the Gate Array of the SRT Control board the signal HVOK and the red LED DL3 (HVOK), mounted on the SRT Power lights-up.

The VMOD is applied to the primary of the HVPS TRANSFORMER which, driven by the MOSFET, generates as output the required high voltage (700 V).

The Mosfet enabling is controlled by a circuit, which, also protects the MOSFET, itself.

The circuit is composed by the blocks COMPARATOR, POTENTIOMETER and FLYBACK CONTROLLER. When the COMPARATOR recognizes HVON signal to be low, enables the FLYBACK CONTROLLER that in turn enables transformer Mosfet output; in the feedback loop another comparator assures that high voltage value is stable and correct. This action is performed by potentiometers and LPA, MPA and SPA signals. In this way, it is possible to control the Magnetron output power.

HVPS unit generates an additional 150 V voltage for a neon lamp performance monitor, for future use.

3.2.1.4 SRT MOS Board

Two configurations are available one for 12 KW and one for 25 KW, the number of MOSFET transistor switched differ in these two versions.

Basically the SRT MOS board (see figure 9.16) performs the following main function: High Voltage Pulses generation for Magnetron.

The Pulse Circuit Generator's function is to generate the necessary high voltage supplying the Magnetron, according to the previous selections.

The Input Pushing Trigger is TRPUSH and the input Pulling Trigger is TRPULL; both from SRT CONTROL Board. To the Pulse Circuit Generator is applied as well the 700 V from the HVPS Generator Circuit.

To one terminal of the primary windings of the PULSE TRANSFORMER is applied the 700V whilst the second terminal is connected to the MOSFET (push and pull).

The pulse is generated in accordance with TRPULL and will be pushed in accordance with TRPUSH; in fact there is current only when the Transformer is grounded with the TRPULL. Every time there is 700 V on the primary, there is, as well, 6 kV on the secondary windings of the PULSE TRANSFORMER. According with this configuration the R.F. is sent to the antenna from the Magnetron.

In order to get the best operating conditions for the Magnetron, there is also a need to energize magnetron filament with a 6.3 V Filament Voltage (voltage changes slightly depending from the magnetron installed), named VFIL which is applied to a section of the secondary windings of the PULSE TRANSFORMER. As result, the signal FIL. sent to the Magnetron, has always a potential 6.3 V greater than the K potential.

While the SRT is Transmitting, the CURRENT TRANSFORMER generates the signal MCUR which:

- is used in this circuit to block high voltage to magnetron when current absorbed by magnetron is too high.
- is sent to the Gate Array of the SRT Control Board
- is sent to the Microprocessor of the SRT Control Board

3.2.1.5 SRT CONTROL Board

The SRT CONTROL Board (see figure 9.18) is located in the Electronic assembly, and his function is to control all SRT operations.

The SRT CONTROL Board is divided in the following main circuits:

- Microprocessor and Gate Array
- System monitor
- Performance Monitor
- Input and Output Interface

3.2.1.6 Microprocessor and Gate Array

General Description

The heart of SRT Control Board, is an advanced 32 Bit MCU (Micro-controller Unit) (see figure 9.18), with highly sophisticated, on chip, peripheral capabilities and performing the function of:

- managing all functions of the SRT unit on the basis of commands/data from the Display Unit
- preparing the feed-back signals to be sent out to the Indicator unit
- executing all internal processing to assure the SRT units control and monitoring

The Microprocessor used in the board is the MCF5211 with these characteristics:

- 16 KB SRAM,
- 128 KB Flash Memory,
- Two UARTs,
- Queued serial peripheral interface (QSPI) with four peripheral chip selects,
- Four 32-bit timer channels with DMA capability,
- Four 16-bit timer channels for capture, compare and pulse width modulation (PWM),
- Four - channel 16-bit/8-channel 8-bit PWM generator,
- Two periodic interrupt timers (PITs) for alarm and countdown timing,
- Eight - channel 12-bit ADC
- System integration (PLL, SW watchdog)
- Up to 33 general-purpose I/O

The SRT unit management is performed by the Microprocessor that does not require any external PROM or RAM elements. Its own memory, in fact, has sufficient capacity to store the Operative Program. It is using an external U18 EEPROM, (see figure 9.17, pos. 1) for store transmitting parameters. The necessary clock pulse of 50 MHz generated by the crystal oscillator.

In figure 9.19 are displayed the Microprocessor and Gate Array general configuration, the main sub-systems and how they relate to the pins of the MCU.

Funtions Performed

The main functions performed by the Microprocessor with the Gate Array (see figure 9.20 and 9.21), on the basis of commands and selections, Remote, (from Display Unit) or Local, (Trough the Selector), are:

- to initialize the TXRX operations
- to generate the trigger pulse for SRT MOS Board and the trigger (TR) pulse for the Display Unit and the P.M. function
- to generate the PRESTC waveform for the RF Detector asembly (STC) and the selection commands for band-width of Receiver
- to generate:
    - o the VCO forwarded to Mixer
    - o the control signals forwarded to SRT MOS and SRT Power Boards
- to receive the signals producing the Antenna rotation
- to perform the processing on various sensor signals in order to monitor the correct operations of the TXRX unit.

Microprocessor output signals

TR	Transmission Trigger.
CS0, CS1, SCK, SO	Serial Gate Array and EEprom management signals
TX	Asynchronous serial transmission
/RES	Asynchronous Reset

Microprocessor input signals

VDLEVEL	Main bang Video signal level the value is send, in serial mode, to the Display Unit
PWLEVEL	Information about the Power Level; the value is send, in serial mode, to the Display Unit
MCUR	Magnetron cathode current pulse sample the value is send, in serial mode, to the Display Unit
VFIL M	VFil Voltage value
24 VCO M	+24Vco Voltage value.
12 VT	40 to 60VDC Main Power Voltage value
15 M	+15V Voltage value.
TEMP	Temperature value; the value is send, in serial mode, to the Display Unit
+5V M	+ 5V Voltage value.

(continue)

- 5V M	- 5V Voltage value.
- 15V M	- 15V Voltage value.
Monitor M	Information about the L.N.F.E. status.
AZ	Antenna azimuth pulse
HL	Antenna ship reset pulse
RX	Asynchronous serial receive
IRQ	Video data Reception/Transmission Interrupt.
NMI	Power supply line absence.
CK10	50 MHz clock
SCK, SI	Serial Gate Array management signals

Gate Array Input Signals

CK50	Input for the 50 MHz clock.
ANTBLK	High voltage generation and antenna rotation disabling from the Safety Switch.
SLK	High voltage generation and antenna rotation disabling from the interlock.
LINE	Main power supply voltage
HV OK	High voltage supply feedback
HV Stop	Feedback from SRT MOS board for +15Iso presence
MPLC	Magnetron transmission current.
P1 and P2	Links for the board configuration.
S1 selector	4 bit for the selector position.
TR	Transmission Trigger.
CS1, SCK, SO	Serial Gate Array management signals
TRSTC	Pre-trigger for the STC generation.
RXCOMB	Serial reception of the combined video.

Gate Array Output Signals

DATA BUS	Bit DB0-DB7 of the Data Bus.
NMI	Power supply line absence.
IRQ	Video data Reception/Transmission Interrupt.
CK10	10 MHz clock
CS0-CS7	Digital potentiometer chip select.
U/D, INC	Digital potentiometer control signals.
SWFIL1-2-3	Magnetron filament voltage control signals.
ANTS	Antenna switch on signal.
SPA, MPA, LPA	HVPS circuit control signals.
HVON	HVPS circuit switch on signals.
SWB1-SWB2	Signals for the control of the NIFB bands.
TRPS	Trigger PUSH for the transmission pulse generation.
TRPL	Trigger PULL for the transmission pulse generation.

(continue)

/TR Out	Trigger for the display
/GSTC	Gate for the STC signal generation.
TXCOMB	Serial transmission of the combined video.
DIS TX	Disabling for the combined transmission on the video.
TUNEN and /TUNEN	Tuning detectors at transmission frequency
PM Out	
SCK, SO	Serial Gate Array management signals

Gate Array pulse length generator

The Pulse Length Generator Function (see figure 9.21) provides the length of the generated pulse in accordance with the previous selections.

This function is performed by the Gate Array, which generates the signals TRPS and TRPL when:

- the signal TR is active
- the signal HVOK is low
- the 50 MHz clock is present
- the signal RESET is high
- the signal LINE is true
- the signal SLK is high
- the signal ANTBLK is high
- Main Line ≥ 40VDC

The signals TRPS and TRPL are applied to the DRIVER which generates the signals TRPUSH and TRPULL for the Pulse Generator circuit of the SRT_Mos Board.

3.2.1.7 System monitor functions

System state monitor (see figure 9.22) is performed by this unit. Unit is composed of:

- Voltage Monitor
- Temperature Monitor
- SLK
- Safety switch

Voltage monitor performs monitoring of power supply voltage level. It receives its inputs from the Voltage sensor of the SRT Power Board.

Temperature monitor detects temperature value to be processed by the microprocessor. In case of high value the microprocessor generates the signals for switching the fan on through the Gate Array.

SLK is a signal from switch that disables transmission and antenna rotation when the apparatus cover is open.

Safety switch disables the radar unit from hazardous power supply. The safety switch must be operated when radar unit is under maintenance to prevent high voltage hazard for operators.

3.2.1.8 Performance monitor functions

The Performance Monitor's function is to monitor Transmission Power, Tuning and Noise Figure in order to result in a Noise Ring presentation on PPI and for to have the peak power value on TXRX DATA.

In the related circuit there is a diode, put inside the RF Head, operating as a revelator when the magnetron send the power in output or as noise generator when the signal PM_Out is available.

When the diode is operating as revelator, it is synchronized with the transmission and the revelator circuit can detect the power present at the diode; this circuit is always activated, the measurement is made every trigger and the measured value is available on TXRX data.

When the command PMON, Performance Monitor ON, is inserted**,** the power value and the tuning value are arranged to change PM_Out signal parameters. The scope of this circuit is to introduce a noise ring on PPI. This noise ring change its distance by the variation of the transmitting power and its thickness by the variation of the tuning.

A neon lamp, placed in front of the Antenna, on a monitor arm extending from the antenna pedestal, powered by 150 Volt forwarded by POWER MOS Board, is excited at each antenna scan by the radiated RF pulse energy, any time the RF beam crosses over.

The result is, that when the Performance Monitor is switched on and the neon lamp is radiated by the Magnetron RF, the RF energy causes a current variation on neon lamp and on RM signal. A revelator circuit provides to detect this variation that interrupts the Noise Ring.

This function supplies to a general verification of the output power sent out.

3.2.1.9 Input and Output Interface functions

The Input interface of the SRT Control board receives input signals from SRT Power, SRT MOS, RF Detector, Safety Switch, interlock and forwards them to the microprocessor and to the gate array. Signal conditioning and level shifting operation is accomplished by buffers, level translators and peak hold devices.

Azimuth (AZ-in) and Heading Line (HL-in) input signals are processed as well and forwarded to the microprocessor and the gate array (AZ, HL)

The Output interface forwards processed signals from Gate Array, RF Detector, Safety Switch and from the TX pin of the microprocessor to the Display, the RF detector and the brushless motor controller board.

3.2.1.10 Azimuth (AZ) and Heading Line (HL) Signal Circuit Generator

The Antenna Unit must constantly forward its Azimuth position and Heading Line to the Display Unit. The function of this circuit (see figure 9.8) is to process the incoming signals AZIN and HLIN and forward them to the Microprocessor.

The output signal AZOUT and HLOUT are used on the Display Unit.

3.2.2 RF Head

The RF Head (see figure 9.23) is composed of a solid state controlled MAGNETRON stage connected to a small size ISOLATOR, then a CIRCULATOR and the NOISE DIODE block ending with a flange to be connected to waveguide in order to transfer the RF PULSE to the FILTER ASSY (composed by two in line pass band filters and a shim) to filter out spurious frequency emissions. From here the pulse pass through a short waveguide up to Rotary Joint connected to the Antenna for it to be radiated.

The opposite end of the CIRCULATOR is fitted with the LIMITER, the RF Amplifier (L.N.F.E + RF Detector). L.N.F.E (Low Noise and Front End) is composed of: the IMAGE REJECTION FILTER, the LOW NOISE AMPLIFIER, two-BALANCED MIXER and the LOCAL OSCILLATOR; RF Detector is the final amplification stage and it is of the logarithmic kind.

The RF Head is designed to generate RF pulses in the X-Band range up 25 kW and to receive echo from targets.

During transmission time, the MAGNETRON receives a high voltage trigger pulse, whose length (short / medium / long) is determined by the operator settings on Display, and generates high power RF pulses in the X-Band range until the high voltage pulse is applied to its cathode.

The RF energy generated is sent to the CIRCULATOR, and from this to the waveguide which delivers the energy for the radiating Antenna.

The CIRCULATOR is a 3-way microwave device used either as a RF switch or to send the transmission pulses to the Antenna or to apply the received echoes to the Receiver.

The second function carried out by the RF HEAD unit is to convert, the receiving R.F. energy, reflected from targets, into intermediate frequency, (I.F.) and amplify it. This is provided by the R.F. HEAD block mainly consisting of:

- Limiter
- Circulator
- Noise Diode
- Power Diode
- Integrated RF Amplifier composed of:
- Low Noise Front End (Low Noise Amplifier, Mixer, LO)
- RF Detector

The echo signal received by the Antenna arrives, through the Limiter and the Low Noise Amplifier, to the Mixer where it is mixed with the signal forwarded by the Local Oscillator. The resulting beat is the 60 MHz IF signal which is forwarded to the RF Detector. The Limiter is used to avoid an output above a scheduled value. A higher output would cause a short-circuit.

The Low Noise Amplifier and the Image Rejection Filter are used to amplify the echo signal in order to improve the noise figure of the receiver. The Local Oscillator is integrated directly into the LNFE. It can be tuned up to the Magnetron transmission frequency through the VCO voltage level.

The RF Detector assembly's function (see figure 9.24 and 9.25) is to amplify the echo signals delivered by the RF HEAD assembly. It is composed of a Group Amplifier stages, cascade connected, with specific components so to obtain a logarithmic dynamic characteristic. The central frequency is 60 MHz and the bandwidth is 1.8 MHz for Long Pulse, 4.5 MHz for Medium Pulse, 24 MHz for Short Pulse.

To maintain the target echo signals free from any possible external induction that can degrade the performance of the Unit, the DC power supply voltages and the band switching commands are applied to the module by means of a FILTER.

3.2.3 Brushless motor controller Board

Speed controller board sets brushless motor rotation speed by means of variable voltage signal VEL coming from SRT Control Board. An enable control 5V signal is produced as well (start), for safety purpose. Turning the safety switch off results in preventing motor from rotating (see figure 9.26).

3.2.4 Motor unit

The Motor Unit, on which 12´ X-Band Antennas is mounted, is equipped with an Electric Motor powered by the Brushless Motor Controller board in the casting (see figure 9.5).

The motion is transferred to the X-BAND ANTENNA through 2 GEARBOX, with a total reduction ratio of 120:1. The ANTENNA nominal angular speed can be ≥ 20 rpm.

On the SRT Control board, it is applied a SAFETY SWITCH. This switch positioned outside the equipment, when open, disables, in the SRT, the power supply for the Motor Unit and inhibits RF emission, thus achieving a safety condition when personnel have to operate on the equipment both for maintenance and for repairing. The wiring from the switch enters in the equipment through the smaller stuffing tube. The installation is compulsory and it is recommended to install the switch at the bottom of the mast stairs giving access to the Unit.

NOTE
Before performing any service on the Antenna, SWITCH OFF the Safety Switch.

3.2.5 Encoder

The function of the Encoder is to increase the angular resolution of the azimuth and heading signal to 4096 pulses for revolution.

On the Antenna shaft is mounted the ENCODER that generates the pulses used to determine the Antenna position (Azimuth) and the Heading Line.

3.2.6 Optional Equipment: SRT Adapter Box

It is possible to connect TRTX units to the Radar Display with lengths of 300 m between.

To ensure adequate signal levels at this distances the SRT Adapter Box has been introduced.

The SRT Adapter Box has the following functions:

- Ensure adequate Power supply level (of 50 V) for the TRTX even at long cable lengths. A 480W AC/DC power supply with universal input from 85VDC to 250 VDC is located on the right part of the box.
- Safety switch location to interrupt the antenna rotation during maintenance.
- The Adapter Box Board within the adapter box ensures correct signal buffering and adjustment of signal levels (amplification) compensating for cable losses.
- Decode the combined video and if needed convert older types of protocol (as Mastermate) to new combined video protocol standards.
- The decoding logic extracts the serial data packets, the trigger and bearing signals from the combined video and translated them in standard levels (for example 232/422 for serial lines)

Figure 9.36 shows the SRT Adapter Box Board layout.

LED D9 is a dual red / green LED. When red the board receives from the display unit. When green transmitting to the display unit.

LED D10 is also a dual red/ green LED . When green, there is a proper signal decoding is going on. When red, there is a parity error at decoding.

This latter LED works when the decoding function is enabled.

3.2.7 Optional Equipment: Heaters

Heaters are introduced for extreme cold environments, when the SRT Radar System is expected to operate down to –40° C.

The HEATER kit, is installed inside the pedestal to heat apparatus and internal units which it is composed when external temperature drops below 0°C. Too much could affect the proper operation of the equipment. It is composed of:

- a control board (SRT HEATER board)
- a thermostat
- two cartridge heaters

The heater system consists of cylindrical heater resistors mounted inside two cavities on the top part of the transceiver. The heaters warm the inside electronics and the Gearbox.

A controller Board stops the heating when temperature is going over 0° C and switches all the available power that is not used by the antenna rotation to the heaters.

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CHAPTER 4
PREVENTIVE MAINTENANCE

4.1 Introduction

This chapter provides necessary informations to execute preventive maintenance operations which must be carried out to ensure the SRT X-BAND RADAR SYSTEM full efficiency.

The maintenance procedures are described in tabular form (card); each card lists the operations, which must be performed, their periodicity, personnel required, the materials and the time required for their performance.

4.2 Preventive maintenance procedure

The preventive maintenance procedures are described by means of cards. Each card, besides indicating the operations to be performed during the maintenance execution, lists the following indications:

- **PERIODICITY**: it is an alphanumeric code identifying the maintenance action described. The following periodicity symbols, as appropriate, are used in order of increasing periodicity intervals as listed in the following:
    - **M**: Monthly
    - **S**: Semi-annual
    - **A**: Annual
    - **W R**: When Required
- **PERSONNEL**: it indicates the number and expertise of the personnel able to perform maintenance operations. On the assumption that the qualification, knowledge, experience and skill needed to fulfil the task are proportional to the ranks, following abbreviations are used:
    - **ST**: is a qualified person with not less than ten years of experience on the job;
    - **JT**: is a qualified person with more than four years of experience on the job;
    - **R**: is a young technician with less than four years of experience on the job, who can be either qualified or undergoing qualification;
- **REQUIRED INSTRUMENTS**: it indicates the tools or the instruments which are used in the card operations; Table 4.1 lists the tools, the instruments and the material required to perform the preventive maintenance operations.

INSTRUMENTS	
Set of Torx screwdrivers	Soft brush
Set of screwdrivers	Soft cloth
Set of socket hexagonal wrenches	Silicone grease
Electro contact cleaner	Dry brush
Alcohol	Dry cloth
Vacuum cleaner	anticorrosive paint
Silicone grease	Air-brush
carbon tetrachloride	Emery paper

Table 4.1 – List of recommended tools and instruments

- **REQUIRED TIME**: it indicates the total time expected to perform the card operations;
- **SAFETY PRECAUTIONS**: it indicates the precaution to be followed in order to ensure a safe preventive maintenance operation execution;

Table 4.2, for each of them, indicates the periodicity and the required time.

CARD	OPERATION	PERIODICITY	REQUIRED TIME
1	Check of the external preservation status	S1	15'
2	Internal inspection and general cleaning	S2	15'
3	Magnetron replacement	WR1-8000h	30’

Table 4.2 – List of the preventive maintenance cards

WARNING

HIGH VOLTAGE IS PRESENT INSIDE THE UNIT. DO NOT OPEN THE FRONT COVER BEFORE THE MAIN LINE BREAKER HAS BEEN TURNED TO OFF POSITION.

CARD 1		
UNIT	**OPERATION**	**PERIODICITY**
SRT X-BAND RADAR SYSTEM	Check of the external preservation status.	S1
PERSONNEL	**REQUIRED INSTRUMENTS**	**REQUIRED TIME**
1R	Vacuum cleaner, emery paper, dry brush, anticorrosive paint,	15 minutes
SAFETY PRECAUTIONS		
On the electric switchboard, set to OFF the power breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".		
STEP	**SEQUENCE OF OPERATIONS**	
1.	Check that no parts of the plastic covering the Antenna have been painted.	
2.	Check the casing preservation state.	
3.	If paint has been scratched off at any point, proceed as follows: - Carefully degrease the part to be painted - Smooth lightly with emery paper - Clean with dry brush - Apply a coat of anticorrosive paint - When the applied anticorrosive is dry, paint with a brush or, better still, by spraying	
4.	On the electric switchboard, set to ON the power breaker relevant to the unit and remove the warning placard.	

Table 4.3 – Preventive maintenance - Card 1

CARD 2		
UNIT	**OPERATION**	**PERIODICITY**
SRT X-BAND RADAR SYSTEM	Internal inspection and general cleaning	S2
PERSONNEL	**REQUIRED INSTRUMENTS**	**REQUIRED TIME**
1R	Set of socket hexagonal wrenches, electro contact cleaner, soft brush, soft cloth, dry cloth, alcohol, carbon tetrachloride, silicone grease, air-brush.	15 minutes
SAFETY PRECAUTIONS		
On the electric switchboard, set to OFF the power breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".		

STEP	SEQUENCE OF OPERATIONS
1.	Position the Antenna as shown in figure 9.1.
2.	By means of the proper socket hexagonal wrench, unscrew and remove the four screws (see figure 9.4, pos. 1) locking the cover (pos. 2) and open the former.
3.	By using the soft brush and vacuum cleaner, remove the dust into the unit.
4.	Check the conditions of each connector electric contacts (pins and plugs), connector packing and of its cable. Clean contacts by using Electro Contact Cleaner. Repair or replace, if necessary, any defective part.
5.	Check the gear integrity. Add grease if the gear shows lack of lubrication.
6.	Check, carefully, that all cabinet internal screws are not loose.
7.	Replace or tighten firmly as necessary.
8.	Cleaning is necessary only when layers, often dark layers, can be clearly seen on some areas. If these layers are visible, they must be removed with a dry cloth. Only if really necessary, repeat the procedure with cloth dampened in carbon tetrachloride. A special brush for cleaning, of appropriate size, may also be used. If and when necessary use an air-brush to remove dust from inside the pedestal.
9.	By using a soft brush and alcohol, remove dust, ash and grease from the internal components.
10.	Dry the surfaces by using a soft cloth.
11.	Grease the fastening screws to avoid corrosion and facilitate future inspections and fix the cover.
12.	Close the equipment cover by following the reverse procedure.
13.	On the electric switchboard, set to ON the power breaker relevant to the unit and remove the warning placard.

Table 4.4 – Preventive maintenance - Card 2

CARD 3		
UNIT	**OPERATION**	**PERIODICITY**
SRT X-BAND RADAR SYSTEM	Magnetron replacement	WR1 (8000 h)
PERSONNEL	**REQUIRED INSTRUMENTS**	**REQUIRED TIME**
1JT	Set of screwdrivers, set of socket hexagonal wrenches, set of Torx screwdrivers, silicone grease.	30 minutes

SAFETY PRECAUTIONS	
On the electric switchboard, set to OFF the power breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".	
STEP	**SEQUENCE OF OPERATIONS**
1.	By following the procedures of paragraph 6.2.2, open SRT unit cover.
2.	Unscrew the four bolts holding protection shield (Figure 9.6, pos. 4).
3.	By means of the proper screwdriver, remove the magnetron wires from the terminal (Figure 9.15, pos.1) tacking note of their disposition: - unplug yellow and green cables loosing the two bolts; - unplug the yellow and green earth cable.
4.	By performing the operations of paragraph 6.2.9 remove electronics assembly.
5.	By performing the operations of paragraph 6.2.8 remove the RF Head.
6.	By means of the proper screwdriver, remove the four Torx screws (Figure 9.27, pos. 2) fixing the magnetron.
7.	Remove the Magnetron.
8.	Before fastening the Magnetron to the proper seat, spread a layer of silicone grease on Magnetron surface which is in contact with the alloy in order to increase the Magnetron heating surface dissipation.
9.	In order to install the new Magnetron, perform the removal operations in reverse order.
10.	**WARNING** IN ORDER TO PREVENT ANY ACCIDENTAL ROTATION OF THE ANTENNA, DISCONNECT THE MOTOR UNIT FROM THE BRUSHLESS CONTROLLER BOARD AND UNPLUG THE 5 PIN CONNECTOR.
11.	Position the selector S1 of SRT CONTROL board (Figure 9.17, pos. 5) on position 2.
12.	Perform the following operations: - on the SRT POWER Board, made a link P1 (see figure 9.10, pos. 1), - before switching on, wait for 30 minutes.
13.	By following the procedures of display manual, perform the VCO calibration.
14.	Perform the following operations: - on the SRT POWER Board remove the link P1 (see figure 9.10, pos. 1), - on SRT CONTROL Board, position S1 (see figure 9.17, pos. 5) on 0 (zero).
15.	Unlock and close the equipment cover by following the reverse procedure.
16.	Grease the fastening screws to avoid corrosion and facilitate future inspections and fix the cover.
17.	On the electric switchboard, set to ON the power breaker relevant to the unit and remove the warning placard.

Table 4.5 – Preventive maintenance - Card 3

CHAPTER 5
TROUBLESHOOTING

5.1 Introduction

5.1.1 General

This chapter provides the procedures to be followed in order to locate faulty component when a trouble is found in SRT X-BAND RADAR SYSTEM.

5.1.2 Organization

The troubleshooting procedures are described by flow charts. When the faulty component is located, please refer to chapter 6 for its replacement.

5.1.3 Personnel

The personnel involved in troubleshooting procedures must be skilled technicians and must have a good knowledge of the equipment.

5.1.4 Tools and instruments

For the execution of the troubleshooting procedures, besides usual tools (screwdrivers, pliers, etc.), refer to table 4.1.

5.2 Troubleshooting Procedures

5.2.1 Safety Precautions

WARNING

SET THE SAFETY SWITCH TO OFF AND HANG TO IT A PLACARD READING “WORK IN PROGRESS - DO NOT SWITCH ON”.

WARNING

OPERATE WITH CARE ON THE TXRX UNIT BECAUSE OF HIGH VOLTAGES AND HIGH POWER.

5.2.2 Troubleshooting operations

The following table describes the failures that can be met during equipment functioning. If another type of failure is met, call the Consilium Service.

FAULT	REFERENCE OF THE REMEDY*														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TXRX does not turn on	•	•	•	•											
Transmitter can't be controlled				•											
Antenna data can't be controlled				•				•	•						
Transmitter performance is low					•					•					
Sector Blanking is not working								•	•						
Antenna does not rotate				•		•					•	•	•		
There is no current to magnetron					•		•							•	
Transmitter does not generate RF						•	•							•	
Antenna rotates, but rotation speed cannot be controlled															•

Table 5.1 – Main possible SRT X-BAND RADAR SYSTEM failures

*REF. REMEDY	POTENTIAL CAUSE	CHECK	REMEDY
1	Power supply is missing or polarity is inverted.	Check DL1 LED status and measure voltage on TB2 on SRT POWER board.	Connect the 50 VDC voltage to the transmitter properly.
2	POWER_ON signal is missing.	Close P1 link on SRT POWER board and make sure the LED DL2 lights on properly.	Replace SRT CONTROL board
3	Voltage supply is too low.	Check DL1 LED status and measure voltage on TB2 on of SRT POWER board.	Connect the 24VDC voltage to the transmitter properly.
4	BNC video cable is interrupted.	Check electrical continuity and insulation from GND.	
5	Magnetron exhausted.	Check magnetron transmission hours and current and need check on console.	Replace magnetron.
6	The safety switch is open.	Check switch position and continuity.	Close the safety switch or replace it.
7	High voltage generator is damaged.	Disconnect 700 V cable from TB3 of SRT POWER board, disconnect motor cables, turn S1 on SRT CONTROL board on position 3 and make sure DL3 is off.	Replace SRT POWER board.

(continue)

8	Cable between encoder and SRT Control boards is interrupted	Check electrical continuity of the cables	Replace cable
9	Circuits are damaged.	Check input and output azimuth signals on SRT CONTROL board.	Replace the damaged board.
10	High voltage is too low.	Check magnetron current and 700 VDC voltage value.	Adjust high voltage values on SRT POWER board.
11	Motor power supply is missing.	Check if 24VDC voltage value on Brushless Motor Controller ends is low or missing.	Connect the 24 VDC voltage to the controller properly.
12	Motor power supply is missing.	Check brushless if motor controller enable signals are missing.	Replace SRT Control board
13	Motor power supply is missing.	Check brushless if motor controller enable signals are present.	Replace the brushless motor controller.
14	Modulator is damaged.	Disconnect 700 V cable from TB3 of SRT POWER board, disconnect motor cables, turn S1 on SRT CONTROL board on position 3 and make sure DL3 is off.	Replace SRT MOS board.
15	Brushless motor controller is not enabled properly.	Check brushless motor controller signals.	Replace SRT CONTROL board.

Table 5.2 – Main possible SRT X-BAND RADAR SYSTEM remedy

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CHAPTER 6
CORRECTIVE MAINTENANCE

6.1 Introduction

This chapter provides the necessary information to execute the corrective maintenance operations which must be carried out in order to ensure "SRT X-BAND RADAR SYSTEM", correct functioning, according to the troubleshooting procedures of chapter 5.

Obviously, the replace operations will only be described for the parts that can be supplied as spare parts (refer to chapter 7).

6.1.1 Safety precautions

If not otherwise specified in the procedures, during corrective maintenance operations, the following safety rules must be observed:

- each maintenance operation must be carried out only after the equipment has been switched-OFF.

WARNING
SET TO OFF THE MAIN BREAKER OF THE EQUIPMENT AND HANG TO IT A PLACARD READING "WORK IN PROGRESS DO NOT SWITCH ON".

- before removing any component, be sure the spare part is available.
- verify the integrity of the spare part and, if possible, perform a functional test.

6.1.2 Personnel

The replacement operations must be carried out by skilled personnel with a good knowledge of the equipment.

6.1.3 Required tools and instruments

To carry out the replacement operations described in this chapter, only normal workshop tools (as screwdrivers, wrenches etc.) are required.

The tools required to perform troubleshooting operations are listed in the following table:

INSTRUMENTS	
Set of screwdrivers	Set of communication tools
Set of combination wrenches	30W welders
Set of socket wrenches	Electric solder iron
Set of socket hexagonal	Desoldering tool
Set of socket Torx	Vacuum cleaner
Set T-handle wrenches with swivelling hexagon sockets	Digital multimeter
Set of hexagonal wrenches	Oscilloscope
Set of allen wrenches with end ball	Set T-handle wrenches with swivelling hexagonal sockets
Set of Torx wrenches	Circlip pliers

Table 6.1 – List of recommended tools and instruments

6.2 Corrective Maintenance Procedures

This paragraph provides detailed description of operations to be carried out in order to replace a damaged component, for SRT X-BAND RADAR SYSTEM.

SRT X-BAND RADAR SYSTEM	
PARAGRAPH	**COMPONENT TO BE REPLACED**
6.2.1	Antenna replacement
6.2.3	Motoreducer assembly replacement
6.2.4	Brushless motor controller replacement
6.2.5	Magnetron replacement
6.2.6	RF Head replacement
6.2.7	Electronic assembly removal/installation
6.2.8	Encoder replacement
6.2.9	Performance monitor replacement

Table 6.2 – List of component to be replaced

6.2.1 Antenna replacement

a) Required tools

- Set of combination wrenches;
- Set of screwdrivers;
- Set of socket wrenches.

b) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON";
2. Using the proper open wrench, loose and remove the bolts (Figure 9.2, pos. 2) fixing the antenna (pos. 3) to the pedestal (pos. 1);

c) Installation

1. Check for the integrity of the new antenna;
2. In order to install the antenna, perform the removal operations in reverse order.

6.2.2 Opening/Closing of the TXRX Cover

a) Required tools

- Set of hexagonal wrenches;
- Silicone grease compound 340.

b) Opening

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".
2. By hands, rotate the antenna (Figure 9.2, pos. 3) orthogonally with respect to the cover opening direction as shown in Figure 9.1.
3. Unscrew the four screws (Figure 9.4, pos. 1) locking the cover (pos. 2) and open the former.

c) Closing

1. Check for the integrity of the cover seal (pos. 3) and eventually replace it.
2. Unlock the cover by releasing the locking device and close the cover.
3. Grease the fastening screws and fix the cover.
4. On the electric switchboard, set to ON the power breaker relevant to the unit and remove the warning placard.

6.2.3 Motoreducer assembly replacement

a) Required tools

- Set of combination wrenches;
- Set of hexagonal wrenches;
- Set of allen wrenches with ends ball;
- Set T-Handle wrenches with swiveling hexagonal sockets;
- Silicone grease compound 340;

The motoreducer assembly is composed of:

- motor unit (Figure 9.5, pos.1);
- gearbox (pos. 2).

6.2.3.1 Motor unit replacement

a) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".
2. By following the procedures of paragraph 6.2.2, open the SRT unit cover. Take note of connections displacement in order to be able to reconnect the cables in the proper positions. Unscrew contacts and power supply from brushless motor driver.
3. Holding the motor unit with the gearbox, remove the four screws (Figure 9.5, pos. 4) fixing the group (pos.1 and pos. 2) to the support and remove the group.
4. To separate the motor unit from the gearbox, using the proper hexagonal wrench, loose and remove the four screws (pos.5) and loose the screw (pos.6).

b) Installation

1. Check for the integrity of the new motor.
2. In order to install the motor unit with the gearbox, perform the removal operations in reverse order.
3. Close the cover following the procedures of paragraph 6.2.2.

6.2.3.2 Gearbox replacement

a) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".
2. By following the procedures of paragraph 6.2.2, open the SRT unit cover. Take note of connections displacement in order to be able to reconnect the cables in the proper positions. Unscrew contacts and power supply from brushless motor driver.
3. Holding the gearbox with the motor unit, remove the four screws (Figure 9.5, pos. 4) fixing the group (pos.1 and pos. 2) to the support and remove the group.
4. To separate the gearbox from the motor unit, using the proper hexagonal wrench, loose and remove the four screws (pos.5) and loose the screw (pos.6).

b) Installation

1. Check for the integrity of the new gearbox.
2. In order to install the gearbox with the motor unit, perform the removal operations in reverse order.
3. Close the cover following the procedures of paragraph 6.2.2.

6.2.4 Brushless motor controller replacement

a) Required tools

- Set of screwdrivers;
- Set of combination wrenches;
- Silicone grease compound 340;
- Set of Torx wrenches.

b) Removal

1. By following the procedures of paragraph 6.2.2, open SRT unit cover.
2. Disconnect the brushless motor controller (Figure 9.4, pos. 5) cables, taking note of their disposition.
3. By means of the proper socket wrench, unscrew the four screws (pos. 9) fixing the brushless motor controller to the mechanical frame.
4. Remove the brushless motor controller.

c) Installation

1. Check for the integrity of the new brushless motor controller.
2. In order to install the brushless motor controller, perform the removal operations in reverse order without closing the cover.
3. Close the cover following the procedures of paragraph 6.2.2.

6.2.5 Magnetron replacement

a) Required tools

- Set of screwdrivers;
- Set of allen wrenches with ends ball;
- Set of combination wrenches;
- Set of Torx wrenches;
- Set T-Handle wrenches with swiveling hexagon sockets;
- Set T-Handle wrenches with swiveling hexagonal sockets;
- Silicone grease compound 340.

b) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".

2. By following the procedures of paragraph 6.2.2, open SRT unit cover.
3. Unscrew the four bolts holding protection shield (Figure 9.6, pos. 4).
4. By means of the proper screwdriver, remove the magnetron wires from the terminal (Figure 9.15, pos.1) tacking note of their disposition:
   - o unplug yellow and green cables loosing the two bolts;
   - o unplug the yellow and green earth cable.
5. By performing the operations of paragraph 6.2.7 remove electronics assembly.
6. By performing the operations of paragraph 6.2.6 remove the RF Head.
7. By means of the proper screwdriver, remove the four Torx screws (Figure 9.27, pos. 2) fixing the magnetron.
8. Remove the magnetron.

c) Installation

1. Before fastening the magnetron to the proper seat, spread a layer of silicone grease on magnetron surface which is in contact with the alloy in order to increase its heating surface dissipation.
2. In order to install the new magnetron, perform the removal operations in reverse order.

WARNING

IN ORDER TO PREVENT ANY ACCIDENTAL ROTATION OF THE ANTENNA, DISCONNECT THE MOTOR UNIT FROM THE BRUSHLESS CONTROLLER BOARD AND UNPLUG THE 5 PIN CONNECTOR.

3. On the electric switchboard, set to ON the main line break relevant to the unit and remove the warning placard.
4. Position the selector S1 of SRT CONTROL board (Figure 9.17, pos. 5) on position 2.
5. On the SRT POWER board, made a link P1 (Figure 9.10, pos. 1)

before switching on, wait for 30 minutes.

6. By following the procedures of display manual, perform the VCO calibration.
7. Perform the following operations:
8. on SRT POWER board remove the link P1 (Figure 9.10, pos. 1);
9. on SRT Control board, position S1 (Figure 9.17, pos. 5) on 0 (zero).
10. Unlock and close the equipment cover by following the reverse procedure.

6.2.6 RF Head replacement

a) Required tools

- Set of screwdrivers;
- Set of allen wrenches with ends ball;
- Set of combination wrenches;
- Set of Torx wrenches;
- Silicone grease compound 340;

- Set T-Handle wrenches with swiveling hexagon sockets;
- Set T-Handle wrenches with swiveling hexagonal sockets.

b) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".
2. By following the procedures of paragraph 6.2.2, open the SRT unit cover.
3. Unscrew the four bolts holding protection shield (Figure 9.6, pos. 4).
4. By means of the proper screwdriver, remove the magnetron wires from the terminal (Figure 9.15, pos.1) tacking note of their disposition:
    - Unplug yellow and green cables loosing the two bolts;
    - Unplug the yellow-green earth cable.
5. Disconnect the RF Head (Figure 9.28) cabling, taking note of its disposition;
6. By performing the operations of paragraph 6.2.7, remove the electronics assembly.
7. Using proper allen wrenches with ends ball, loose four screws (Figure 9.29, pos. 1).
8. Holding the RF Head, remove two screws (pos. 2) with proper allen wrenches with ends ball
9. Extract the RF Head (Figure 9.28) from the cover.

6.2.6.1 RF amplifier replacement

1. By performing the operations of paragraph 6.2.6 point b), remove the RF Head.
2. Holding the RF amplifier (Figure 9.28, pos. 1), remove four Torx screws (Figure 9.35, pos. 1) with proper Torx wrenches.
3. Remove RF amplifier.

6.2.6.2 Limiter and noise diode replacement

1. By performing the operations of paragraph 6.2.6 point b), remove the RF Head, after that the RF amplifier.
2. Holding the limiter (Figure 9.28, pos. 2) and noise diode (pos. 3), remove four screws (Figure 9.35, pos. 2) with proper wrenches holding three bolts (pos. 3).
3. Remove the limiter and the noise diode.

6.2.6.3 Circulator replacement

1. By performing the operations of paragraph 6.2.6 point b), remove the RF Head, after that the RF amplifier, limiter and diode noise.
2. By performing the operations of paragraph 6.2.5, remove the magnetron.
3. Holding the circulator (Figure 9.28, pos. 4), remove four screws (Figure 9.35, pos. 4) with proper wrenches.
4. Remove the circulator.

6.2.6.4 Power diode replacement

1. By performing the operations of paragraph 6.2.6 point b), remove the RF Head.
2. Holding the RF Head, remove four screws (Figure 9.35, pos. 4) with proper wrenches.
3. Remove the power diode.

c) Installation

1. Check for the integrity of the new part installed.
2. In order to install the new part, perform the removal operations in reverse order without closing the SRT cover.
3. By following the display technical manual procedures, perform the VCO calibration.
4. Close the pedestal cover following the procedures of paragraph 6.2.2.

6.2.7 Electronics assembly replacement/installation

a) Required tools

- Set of screwdrivers;
- Set of combination wrenches;
- Set of hexagonal wrenches;
- Set of allen wrenches with ends ball;
- Set of Torx wrenches:
- Set T-Handle wrenches with swiveling hexagon sockets;
- Set T-Handle wrenches with swiveling hexagonal sockets;
- Silicone grease compound 340.

b) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".
2. By performing the operations of paragraph 6.2.2, open the SRT unit cover.
3. Unscrew four screws holding protection shield (Figure 9.6, pos. 4).
4. By means of the proper screwdriver, remove the magnetron wires from the terminal (Figure 9.15, pos.1) tacking note of their disposition:
    - Unplug yellow and green cables loosing two bolts;
    - Unplug the yellow and green earth cable.
5. Remove the electronics rack cabling connectors, taking note of their position. Table 6.3 describes connectors to be removed and their position in the SRT unit.
6. By means of the proper screwdriver, unscrew the four screws (Figure 9.29, pos. 1) fixing the electronics rack to the SRT unit cover.
7. Extract the electronics rack from the cover paying attention to the cables and to the rotary joint (Figure 9.31, pos. 1)

6.2.7.1 SRT CONTROL board replacement (Figure 9.6, pos. 2)

1. Remove four Torx screws (Figure 9.6, pos. 5) and disconnect the cabling connectors, taking note of their position.

6.2.7.2 SRT MOS board replacement (Figure 9.6, pos. 3)

1. Remove seven Torx screws (Figure 9.6, pos. 6) and disconnect the cabling connectors, taking note of their position.

6.2.7.3 SRT POWER board replacement (Figure 9.6, pos. 1)

1. Remove eleven Torx screws (Figure 9.6, pos. 7) and disconnect the cabling connectors, taking note of their position.

c) Installation

1. Before installing the new electronics assembly, remove the EEPROM U18 from the old SRT CONTROL board and replace it in new SRT CONTROL board. If this operation is skipped, then the unit must be set up manually from blank to recover values and settings stored in the old board EEPROM.
2. In order to install the electronics rack, perform the removal operations in reverse order.

BOARD	CONNECTOR	PURPOSE
SRT CONTROL	J4	BNC, video signal output
SRT CONTROL	P2	Terminal board for the signal to/from the DISPLAY UNIT
SRT CONTROL	TB1	Safety switch input
SRT CONTROL	J12	Cable for the encoder connection
SRT CONTROL	J1	Small BNC, video signal input
SRT CONTROL	J2	Small BNC, tune signal input
SRT CONTROL	P1	RF amplifier controls
SRT CONTROL	TB3	Terminal board for brushless motor controller
SRT POWER	TB2	Main ower input
SRT MOS	A – K – Fil	Magnetron terminals

Table 6.3 – Electronic rack connectors

WARNING

WHEN THE ELECTRONICS RACK IS INSERTED ON THE FIXING BOLTS PAY A LOT OF ATTENTION NOT TO DAMAGE THE WAVEGUIDE JOINT (FIGURE 9.31, POS. 1)

6.2.8 Encoder replacement

a) Required tools

- Set of screwdrivers;
- Set of hexagonal wrenches

b) Removal

1. By following the procedures of paragraph 6.2.2, open the SRT unit cover.
2. Disconnect encoder cables (Figure 9.30, pos. 4) to the SRT CONTROL board.
3. By means of proper hexagonal wrenches, unscrew the two screws (pos. 1), fixing the mechanical part (pos. 5) to the SRT unit cover, and remove it.
4. By means of proper hexagonal wrenches, unscrew the two socket set screws (pos. 6), fixing the gear (pos. 7) to the encoder shaft, and remove it.
5. By means of proper screwdriver, unscrew the three screws (pos. 3), fixing the encoder to the mechanical part, and remove it.

c) Installation

1. In order to install the new Encoder, perform the removal operations in reverse order

6.2.9 Performance monitor replacement

a) Required tools

- Set of hexagonal wrenches;
- Silicone grease compound 340;
- Set of combination wrenches.

b) Removal

1. On the electric switch board, set to OFF the main line breaker relevant to the unit and hang to it a placard reading "WORK IN PROGRESS - DO NOT SWITCH ON".
2. Using the appropriate wrenches remove four screws (Figure 9.3, pos. 5).
3. Remove the performance monitor (pos. 6).

c) Installation

1. Check for the integrity of new performance monitor.
2. In order to install performance monitor, perform the removal operations in reverse order.

CHAPTER 7
PART LIST

7.1 Introduction

This chapter provides the list SRT X-BAND RADAR SYSTEM replaceable parts.

7.2 Parts list

The part list are divided into major assemblies. All parts attached to the assemblies are listed in the following table. The “Part list tables” consist of four columns as follows:

- Column 1: **FIG./POS**. (Figure/Position): the column reports replaceable parts’ position in the reference figure.
- Column 2: **DESCRIPTION**: the column includes descriptive identification data of the replaceable part.
- Column 3**: DRAWING SPECIFICATION NUMBER OR TYPE**: the column reports drawing specification number or type of the replaceable part assigned by the supplier.
- Column 4: **REQUIRED QUANTITY (N)**: the column indicates, for each replaceable part, how many of them are assembled on the equipment.

7.3 Part location illustration

The following figure and the figure in chapter 9 provides the location of the components. Position numbers of items shown in the figure are referenced in related “Parts list tables”.

7.4 Part list table

FIG./POS.	DESCRIPTION	PART NUMBER	REQUIRED QUANTITY (N)
Figure 9.3, pos. 6	Performance monitor arm	SP-304316A1-001	1
Figure 9.4, pos. 3	Gasket GACO	SP-305079G1-001	1
Figure 9.4, pos. 5	Brushless motor driver	SP-304427A1-001	1
Figure 9.5, pos. 1	Motor unit	SP-305307A1-001	1
Figure 9.5, pos. 2	Gearbox	SP-305283A1-001	1
Figure 9.6	Electronic assembly 25 kW	003-9954-00	1
Figure 9.6, pos. 1	SRT PWR-DC board	SP-973261A3-001	1
Figure 9.6, pos. 2	SRT CONTROL board	SP-973281A2-001	1
Figure 9.6, pos. 3	SRT MOS board 25 kW	SP-973271A5-001	1
Figure 9.27, pos. 1	Magnetron X-Band 25 kW	SP-305078A2-001	1
Figure 9.28, pos. 1	RF amplifier	SP-305098A1-001	1
Figure 9.28, pos. 2	Limiter	018-0163-01	1
Figure 9.28, pos. 3	Noise diode	SP-305155A1-001	1
Figure 9.28, pos. 4	Circulator	SP-89A504P001-001	1
Figure 9.28, pos. 5	Power diode	SP-305274A1-001	1
Figure 9.28, pos. 6	Insulator	023-0023-00	1
Figure 9.30, pos. 2	Encoder 4096 ppr	SP-305342A3-001	1

Table 7.1 – System part list

CHAPTER 8
INSTALLATION

8.1 Introduction

This chapter of the technical manual can be used as a self-contained installation manual for the SRT X-BAND RADAR SYSTEM with 6 feet antenna. It contains necessary information, pictures and drawings to handle, assemble and install this unit as a part of the complete radar equipment. Actions how to prepare this unit for the radar equipment setup procedure are also described.

8.1.1 Shipping

Following general rules apply:

- Inspection for damage during transport;
- When unit arrives at destination, inspection should be performed immediately to register any damage that may have occurred during transfer;
- The customer is normally responsible for insurance during the transportation. If any damage is found, both the insurance company and the shipping agent must be informed immediately.

8.1.2 Unpacking

The unit parts are placed in cardboard boxes covered with a plastic sheet. Each box includes a protecting polyurethane box shaped for the contained parts.

The following rules should be observed:

- Units must be transferred on board still packed into their boxes;
- When the units are removed from their boxes they must be left in their protective plastic cover until installation;
- It is advisable to keep the packing material for possible future use the plastic sheet in which the unit is wrapped can be used to protect it during installation and maintenance procedures.

In addition to the various main parts forming the unit there is further materiel included in the delivery. Those additional things are:

- Technical manual with installation manual included;
- Installation kit (terminals, clamps, connectors etc.);
- Standard spare part kit (fuses etc.);

The installation kit and the spare part kit is necessary for the installation and operation of the equipment, and must be kept by them who perform the installation work. Kit contents should be checked immediately after unpacking, using the materials list contained in the box. The manufacturer will not accept claims for missing items unless presented immediately after unpacking.

8.1.3 Storage

After the material contained in the boxes has been inspected in the presence of customer and it has been verified that no damage has occurred, the unit shall be stored in its original packing until the time of installation. The storage premises must be dry and well protected.

If the units must be kept in storage for more than one month, it is advisable to insert hygroscope substances, such as silicone gel salts, in the crates.

8.1.4 Handling

Antenna and pedestal must be run up the mast separately and then assembled.

The pedestal is lifted by crane. Use slings attached to the eyebolts fitted on top of the pedestal. Minimum angle at the base is 60º (see Figure 8.5).

The pedestal contains delicate electronic components - handle accordingly.

The antenna surface is sensitive to impacts and pressure. Any deformation of the antenna surface can reduce the radar performance. Lift the antenna in slings, carefully preventing it from slipping.

8.2 Installation

In order to obtain the best radar performance and accessibility, the following precautions should be used:

- space for the antenna to swing freely;
- safety and easy access for maintenance purposes. It is preferable to use a platform on the ship mast;
- suggested Masthead antenna mounting (see Figure 8.1);
- antenna must be accessible in all directions;
- avoid exposure to exhaust fumes from the funnel;
- avoid strong vibrations;
- avoid interference between other antennas;
- avoid obstacles in the radar beam, especially ahead of athwart ships directions.

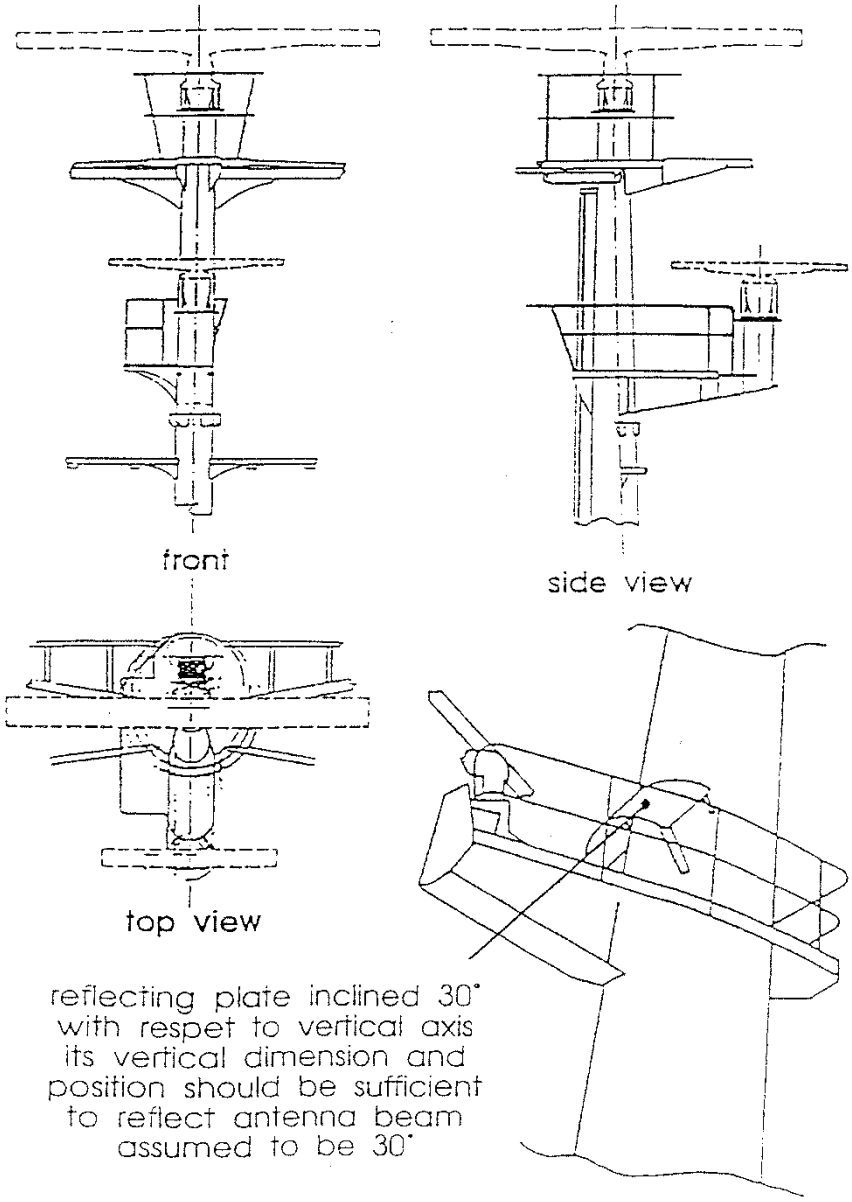


Figure 8.1 – Masthead mounting view

If two radar sets are installed, their antennas should be installed on different levels.

The antennas can be mounted, either on a single mast construction, so they are on top of each-other, as illustrated in Figure 8.1 or the antennas can be mounted on a platform like Figure 8.2 one on portside and one on starboard side.

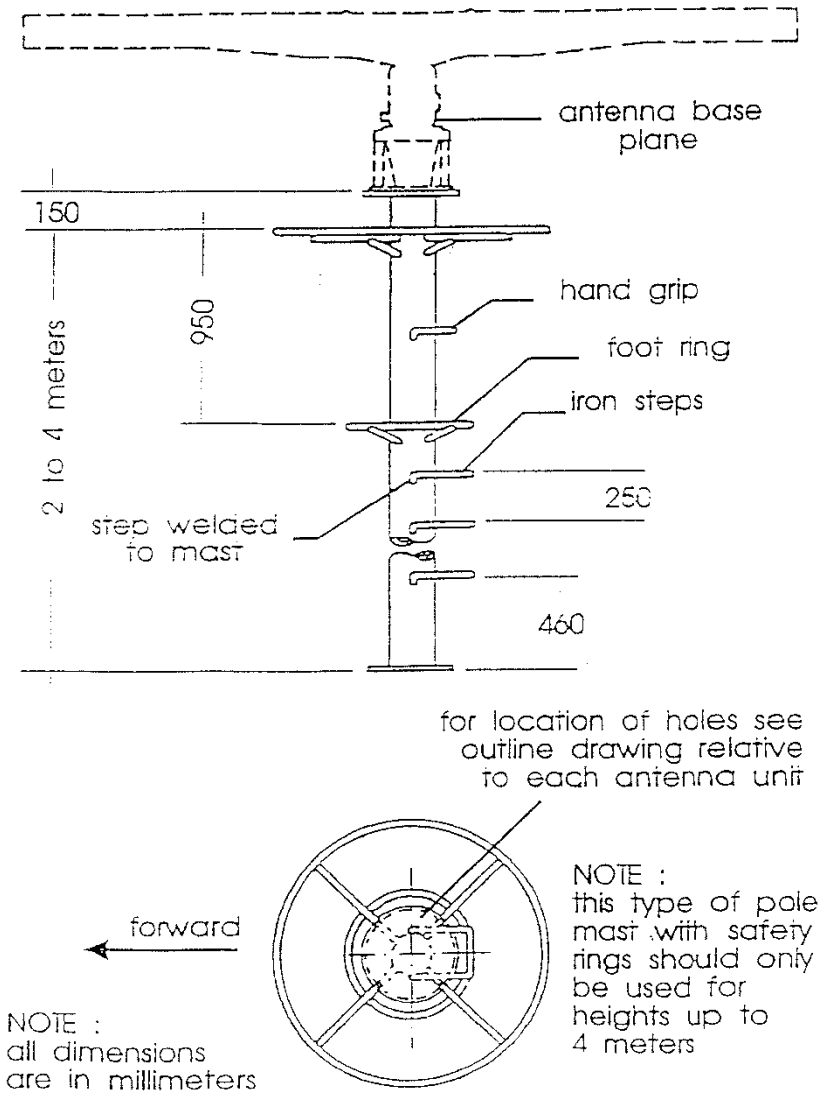

antenna base plane
150
950
2 to 4 meters
hand grip
foot ring
iron steps
250
step welded to mast
460
for location of holes see outline drawing relative to each antenna unit
NOTE : this type of pole mast with safety rings should only be used for heights up to 4 meters
forward
NOTE : all dimensions are in millimeters

Figure 8.2 – Suggested antenna mounting

The following formula and drawing, as illustrated in Figure 8.3 and 8.4, will help you to determine the correct distance and height between the two radar antennas. The 45° angle on the drawing is the actual vertical beam-width with a safety margin included.

Example:

H = L/3

where: H = height between the two antennas

L = the distance between the two antennas

If the distance L is 6m, then the height should be = 2m.

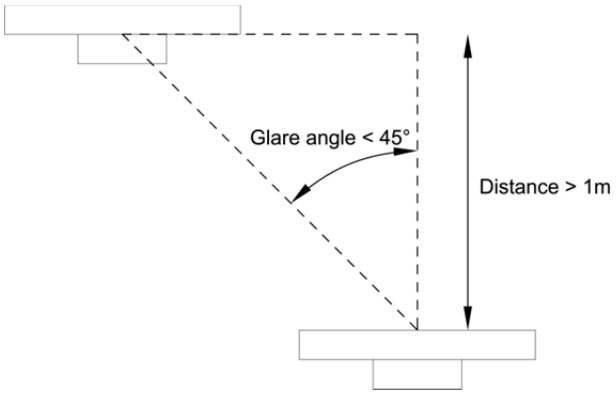


Figure 8.3 – Antenna glare angle

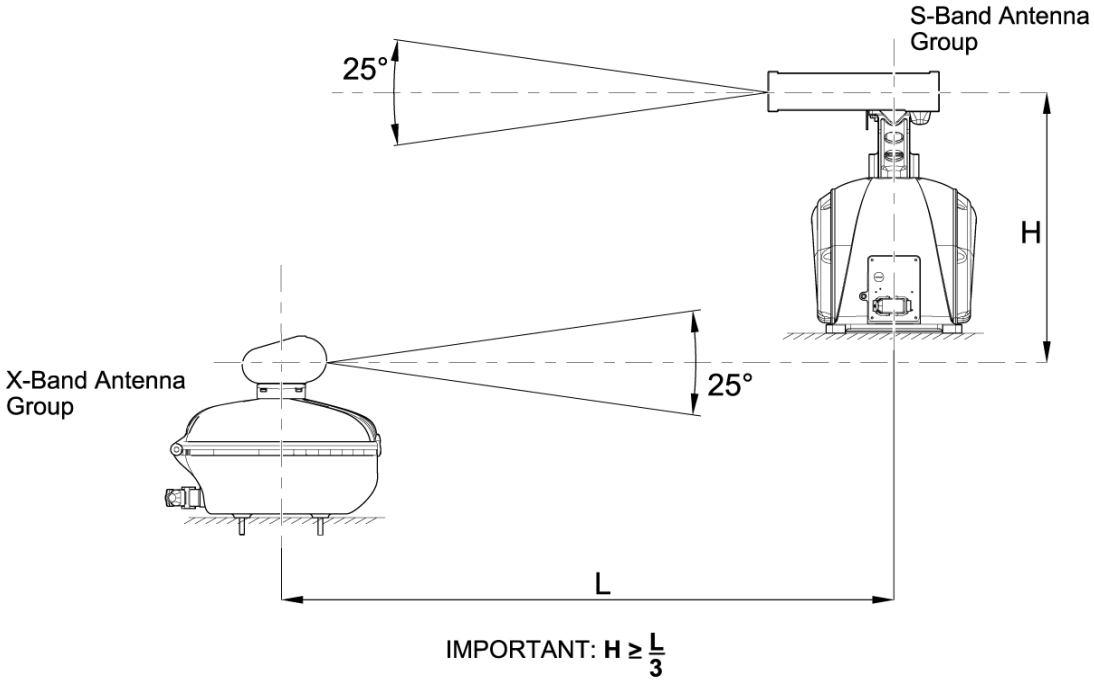


Figure 8.4 – Antenna position

Blind sectors towards the bow and within a few degrees on port and/or starboard side, caused by the structure of the ship, must be avoided with great care. In case of a blind sector at the bow in middle ship position, it is advisable to mount the antennas on the starboard side of the ship keel line.

When obstacles are sufficiently far from the antenna, they will result in a blind sector on the radar display with approximately the same amplitude as observed by the human eye, but these obstacles can produce false echoes. An echo produced by an obstacle close to the antenna, can be suppressed by reflecting the antenna beam skywards by mounting a reflector made of metal, as also illustrated in Figure 8.1. This solution however does not eliminate the blind sector, but will reduce false echoes produced by the obstacle. The best position for the reflector can be found by testing out different positions.

It is highly recommended that the shipyard submit the drawings of the radar antenna position to the manufacturer for approval.

The installation consists of following basic steps:

- mount the unit without the antenna on the mast;
- make relevant connector;
- install and connect performance monitor arm;
- install safety switch;
- mount antenna on the unit.

NOTE

SRT X-BAND RADAR SYSTEM should be installed in such way that the performance monitor arm is not facing funnels or other big ships obstruction. Sector blanking is enabled to prevent false echoes caused by funnels and/or big ships construction (see above). If performance monitor arm is positioned, within this blanking area, the pedestal must be turned because the radar performance monitor is not working where there is no transmission in the sector of its sensor

Installation of safety switch change if it is mounted on the DC CORE or ADAPTER BOX or optional for the ADAPTER BOX external is compulsory. It is recommended to be installed at the bottom of the stairs giving access to pedestal. The waterproof switch is supplied by manufacturer, but a connection cable (2x2,5 mm^2) should be provided by the shipyard.

Antenna group must be covered by plastic sheet during any painting performed after installation.

NOTE

In no case, antenna shall be used to hoist the pedestal up the mast.

8.3 Mechanical installation

8.3.1 SRT X-BAND RADAR SYSTEM

Prepare the platform for mounting of the pedestal, with its built in transceiver. Hole diameters and distances is evident from Figure 9.33.

The pedestal should be mounted with its lid hinges pointed forward and cable glands pointed astern. However the antenna swinging plane must be horizontal in all directions when ship is upright on even keel. Consider giving ample space for service, especially astern of the antenna group. If such space cannot be achieved, contact manufacturer for installation alternatives.

WARNING

NEVER PASS OR STAY UNDER ANY LIFTED OBJECT.

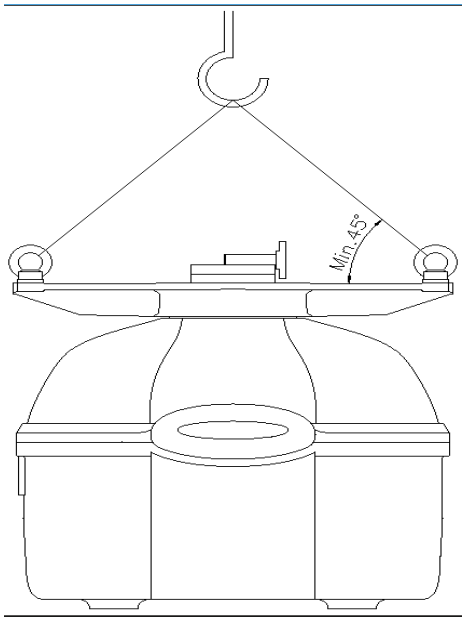


Figure 8.5 – Lifting SRT X-BAND RADAR SYSTEM by crane

NOTE

The protection waveguide covers on the antenna and pedestal must not be removed until when mounting the antenna. Anyhow the waveguide joints may not be uncovered when the antenna is not mounted.

NOTE

The fixing materials to fasten the antenna pedestal to the ship's platform are not provided by the manufacturer. Assuming a platform plate thickness of 20 mm, four M10 stainless steel bolts of 65 mm length, with relative nuts grooves and washers, must be used. The tightening couple is 44 Nm.

8.3.2 Antenna

The antenna and the unit must be run up the mast separately and then assembled. The TXRX should not be lifted with the antenna already mounted.

WARNING

IT IS RECOMMENDED TO USE THE SLINGS FOR LIFTING THE ANTENNA AS SHOWN IN FIGURE 8.2.

The mounting procedure of the antenna to the pedestal consists of following steps:

- remove the waveguide protections on the antenna and pedestal;
- Mount the antenna over its support, check that the waveguide connections are on the same side. The antenna assumes the right position following two reference covers.
- Rest the antenna on the pedestal and tighten the 16 bolts holding the antenna. The tightening couple is 22 Nm.

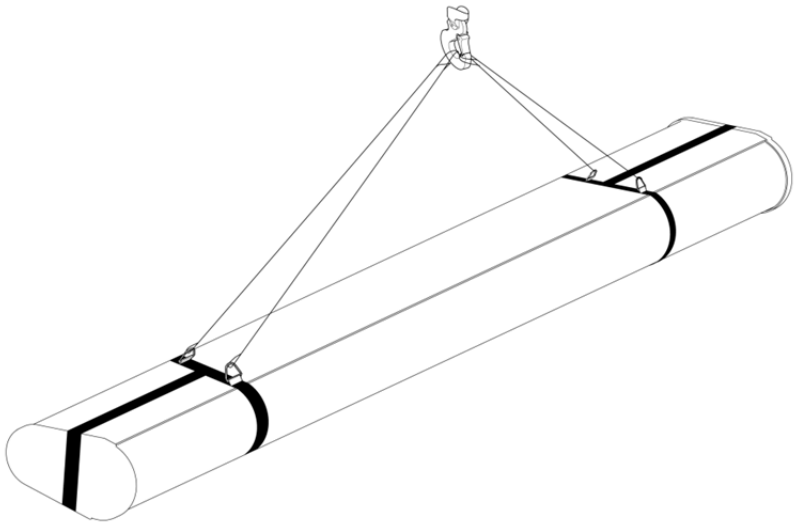


Figure 8.6 – Lifting antenna

8.3.3 Safety switch

Usually the safety switch is located on DCORE or SRT ADAPTER BOX.

Installation of safety switch is compulsory. The optional safety switch can be supplied by the manufacturer.

It is recommended to place the safety switch at the bottom of the stairs that are giving access to the radar mast. The switch must be mounted with the cable glands pointing down. Connect the cable as described in paragraph 8.4 “Electrical installation”.

8.3.4 Performance monitor arm

To install the performance monitor arm proceed as follows:

- connect performance monitor arm for the radiation monitor on the SRT. The arm shall be angled upwards.

8.4 Electrical installation

Electrical installation of SRT X-BAND RADAR SYSTEM consists of cabling and connection to terminals as described below (figure 9.37).

8.4.1 Multicore cable

Also see paragraph 8.5.1 “Multicore Cabling and termination principles”.

NOTE
Use the installation materials for the multicore cable which are delivered by the manufacturer to ensure proper connection.

Normally the cable (4 twisted pair, 2 coax, 8 wire), P/N 55X456P001, is delivered to a length of 30m. The multicore cable includes wires for power, video, trigger and antenna data. It is therefore required to handle these cables with particular care.

The SRT unit end of the multicore cable shall be connected to the main connector (see figure below).

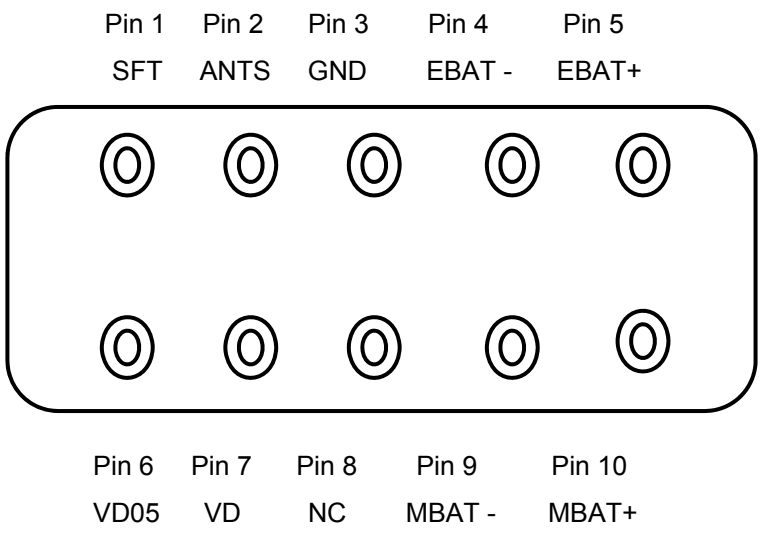


Figure 8.7 – Main connector drawing

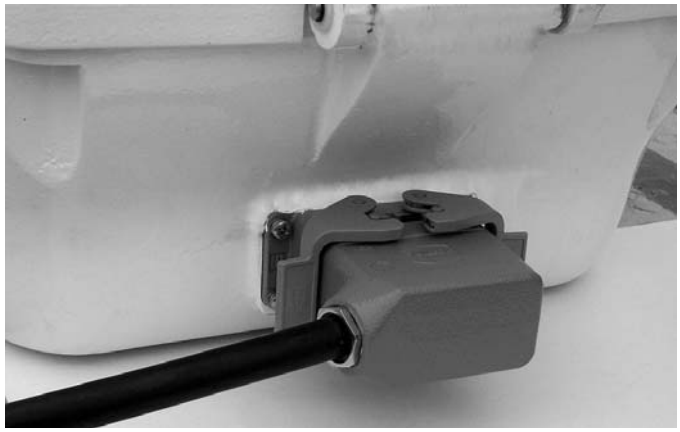


Figure 8.8 – Cable termination

8.4.1 Grounding

Connect a tinned braided copper wire (>25mm^2) between the ground terminal on the SRT unit and the radar mast.

8.4.2 Safety switch

The safety switch is supplied by the manufacturer. Cable from the safety switch to the SRT unit is not included. Following the steps:

- check the safety switch is placed as described in paragraph 8.3 “Mechanical installation”.
- connect the two poles of the safety switch, on TB1 of DISPLAY CORE unit;
- carefully make sure that the switch is closed to “1” (ON) position and open to “0” (OFF) position.

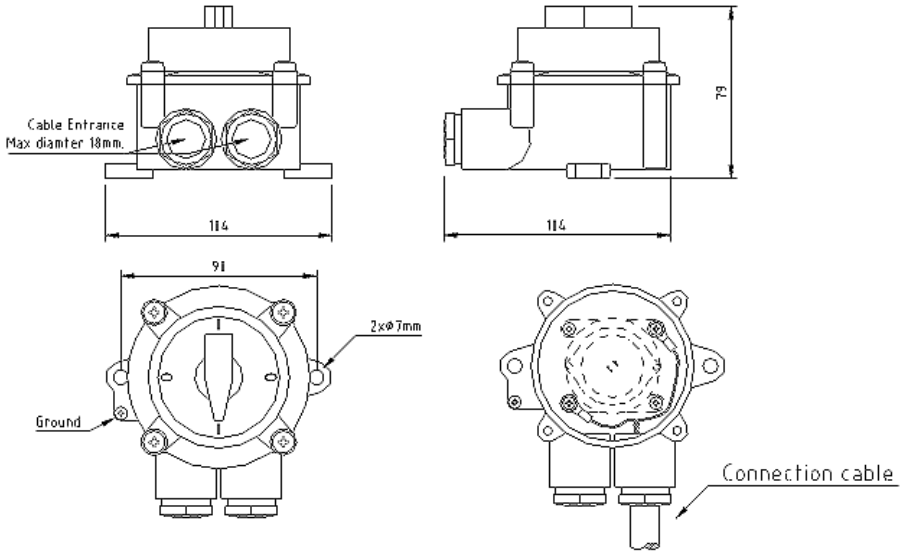


Figure 8.9 – Safety switch view

8.5 System setup procedures

This paragraph provides information concerning the preliminary controls and procedures to be done as a completion of the electrical installation and before supplying the unit with power and before performing the system setup procedure:

- carry out a careful visual inspection of the installed components referring to the layouts of the unit and to the interconnection drawings;
- carefully check the integrity of the fuses.

NOTE
Feed the SRT X-BAND RADAR SYSTEM is not included in the pre setup procedure.

8.5.1 Ship power voltage

SRT unit is connected to ship main voltage through the DISPLY UNIT or SRT ADAPTER BOX. Cable section shall be ≥ 4mm to support a 15A current.

8.5.2 Compass safe distance

Every unit should be located outside the minimum magnetic compass safe distance according to the following table:

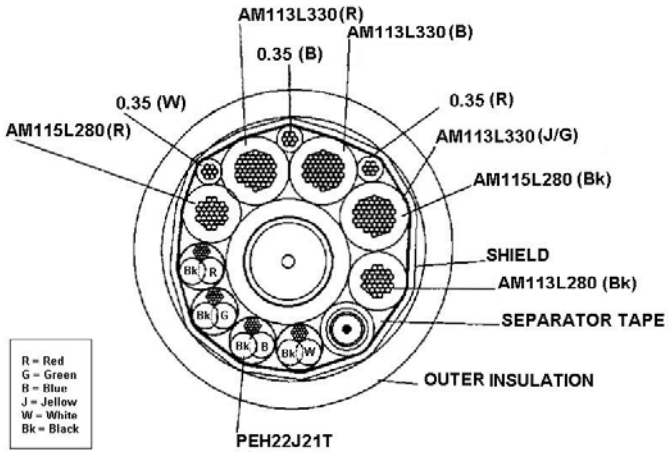
UNIT TYPE	SAFE DISTANCE TO STANDARD MAGNETIC COMPASS (m)	SAFE DISTANCE TO STEERING MAGNETIC COMPASS (m)	REUCED SAFE DISTANCE TO STANDARD MAGNETIC COMPASS (m)	REDUCED SAFE DISTANCE TO STEERING MAGNETIC COMPASS (m)
SRT/25-002	1.35	0.85	0.85	0.55
SRTAB-001	1.20	0.50	0.75	0.30

Table 8.1 – Compass safe distance table

8.6 Multicore cabling and termination principle

8.6.1 Installation instructions

Multicore Cable Technical Specification



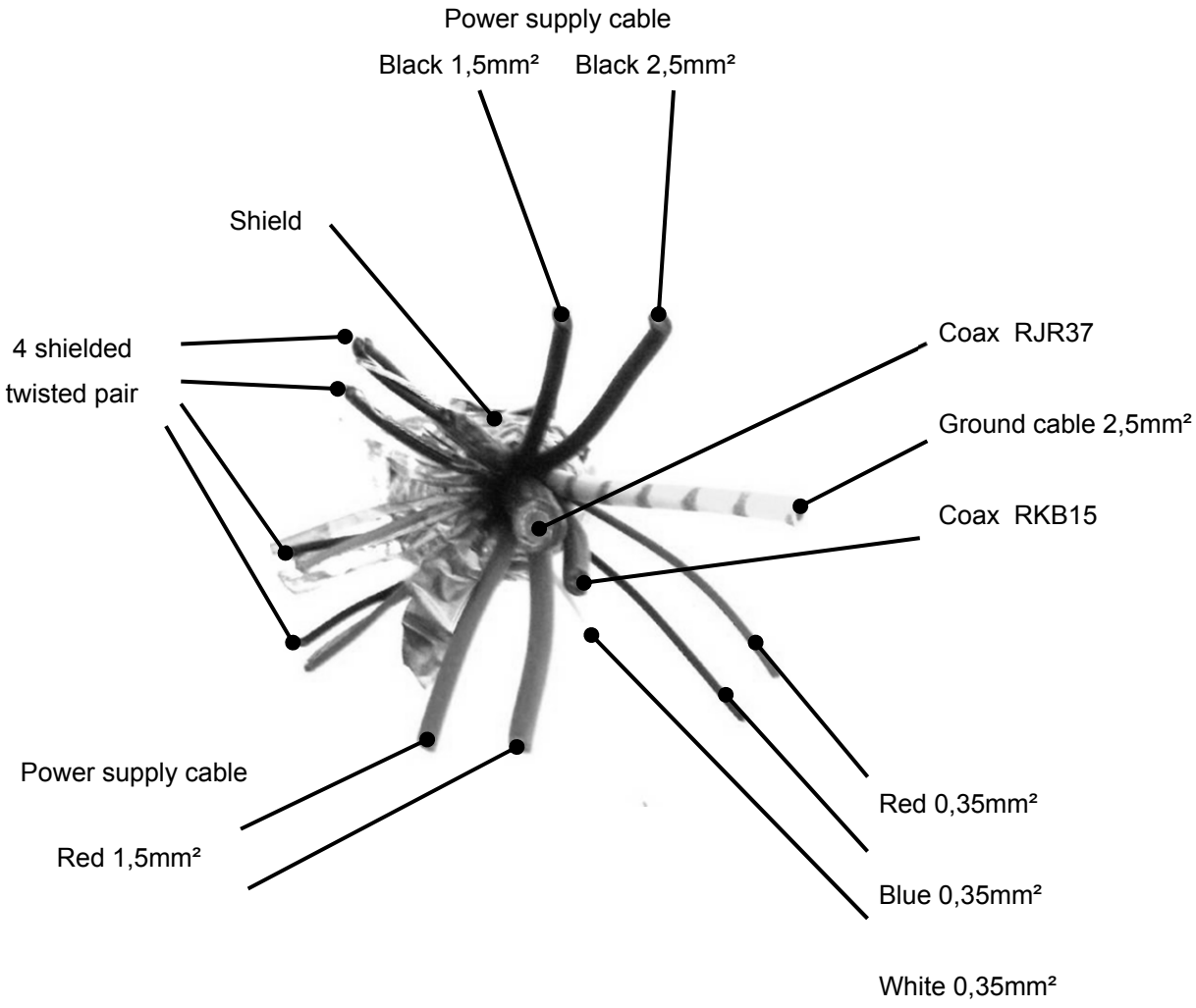


Figure 8.10 – Multicore cable overview

Cable handling

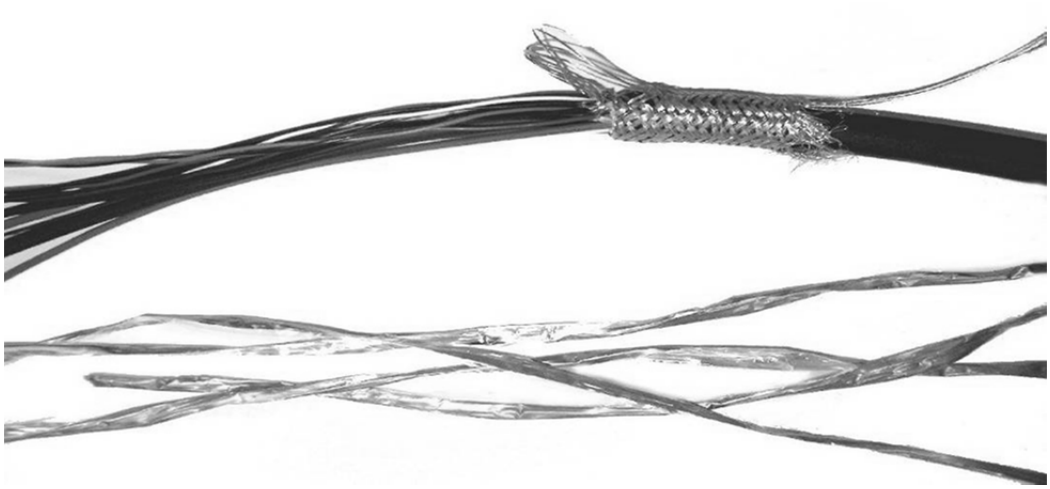
- Dismantle the outer insulation of the cable for 60 cm.

- Remove most of the shield, let it be 5 cm with shield perceptive to vision:

- Remove the main protective film and turn, as in the picture, the shield over the cable outer isolation.

Main Shield and inner shields handling

- Remove the metallic film from each twisted pair cables and pass the 4 ground wires through the turned shield.



0.35 mm² cores

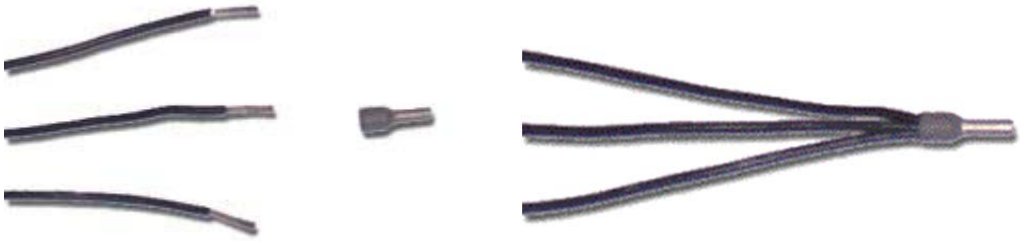
- Cut the core to the wanted length and dismantle the core for 10mm:

- Insert and crimp the blue-end terminal:

Note: End terminal should always be used.

- Double connection in one terminal (yellow terminal):

- Triple connection in one terminal (grey terminal):



1,5 and 2,5 mm² cores

- Cut the core to the wanted length and dismantle the core for 10mm:

Note: End terminal should always be used.

RG coaxial cables

- Mechanical details of BNC connector:

- Cut the cable to the wanted length.

Dismantle the outer isolation of the RG coaxial cable without damaging the shield, and put the related part of the BNC connector as below:

- Details related to the ring of the BNC connector.

- Take back the shield on the ring and trim exceeding shield:

- Dismantle the outer isolation of the centre core without damaging the centre core and be sure that the shield is not shorted with the centre core:

- Solder the centre core with the BNC pin.

Be careful not damage the isolation (i.e. burned) during the solder process:

- Mount the BNC connector as below:

CHAPTER 9
FIGURES

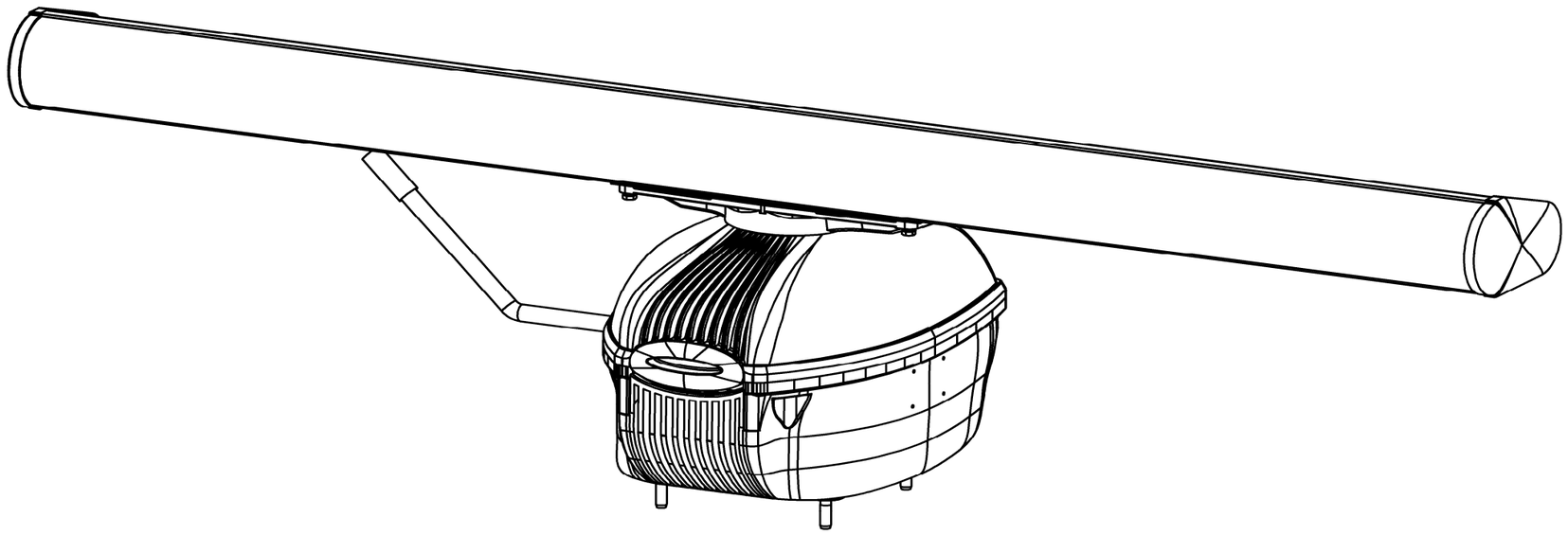


Figure 9.1 – SRT X-BAND RADAR SYSTEM general view

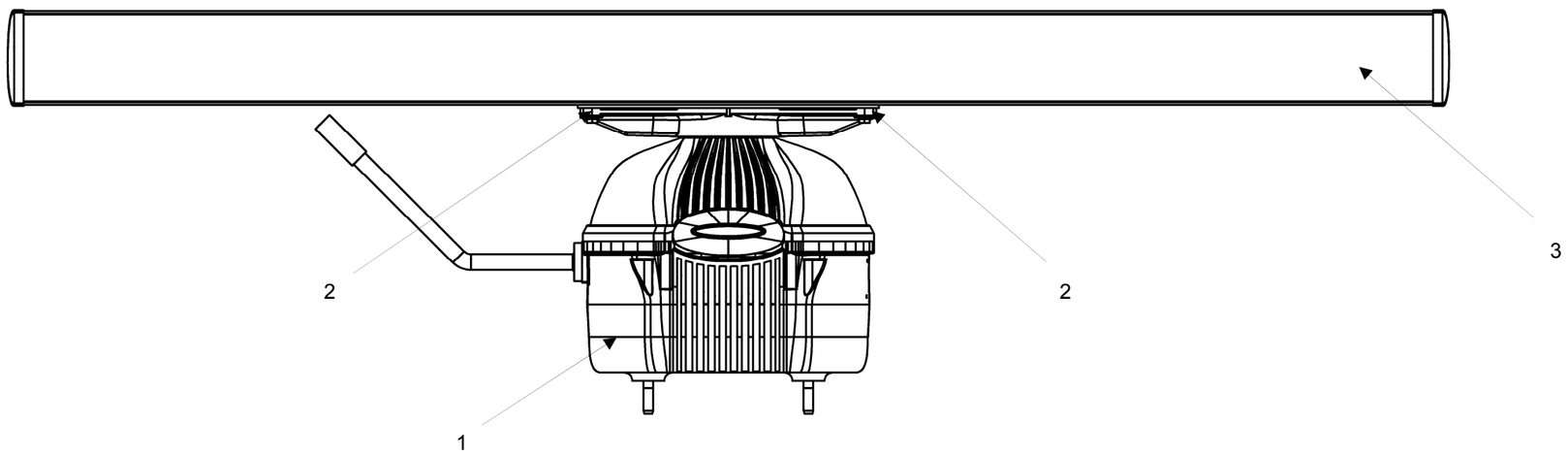


Figure 9.2 – SRT X-BAND RADAR SYSTEM external view

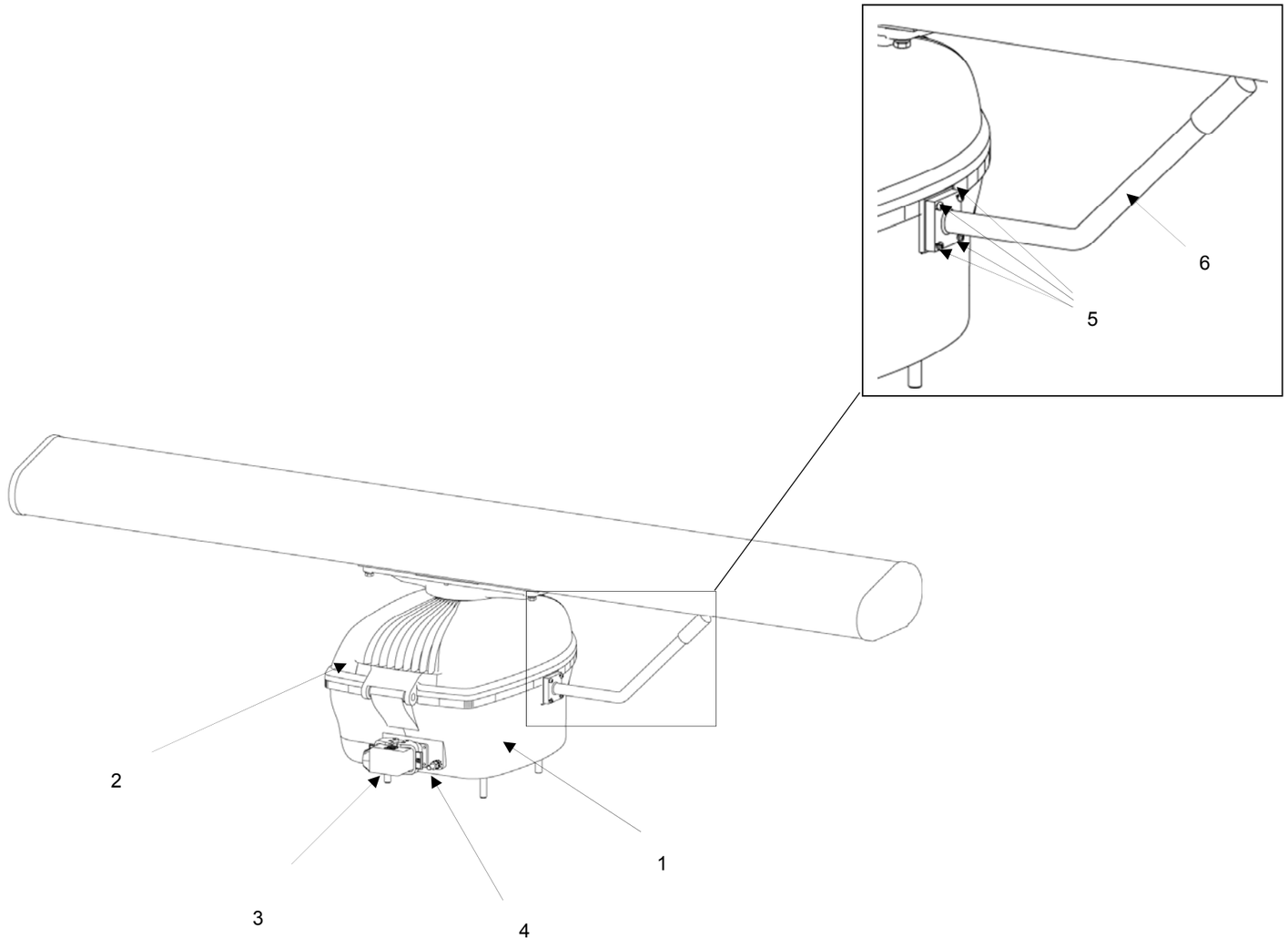


Figure 9.3 – SRT X-BAND RADAR SYSTEM with PM arm

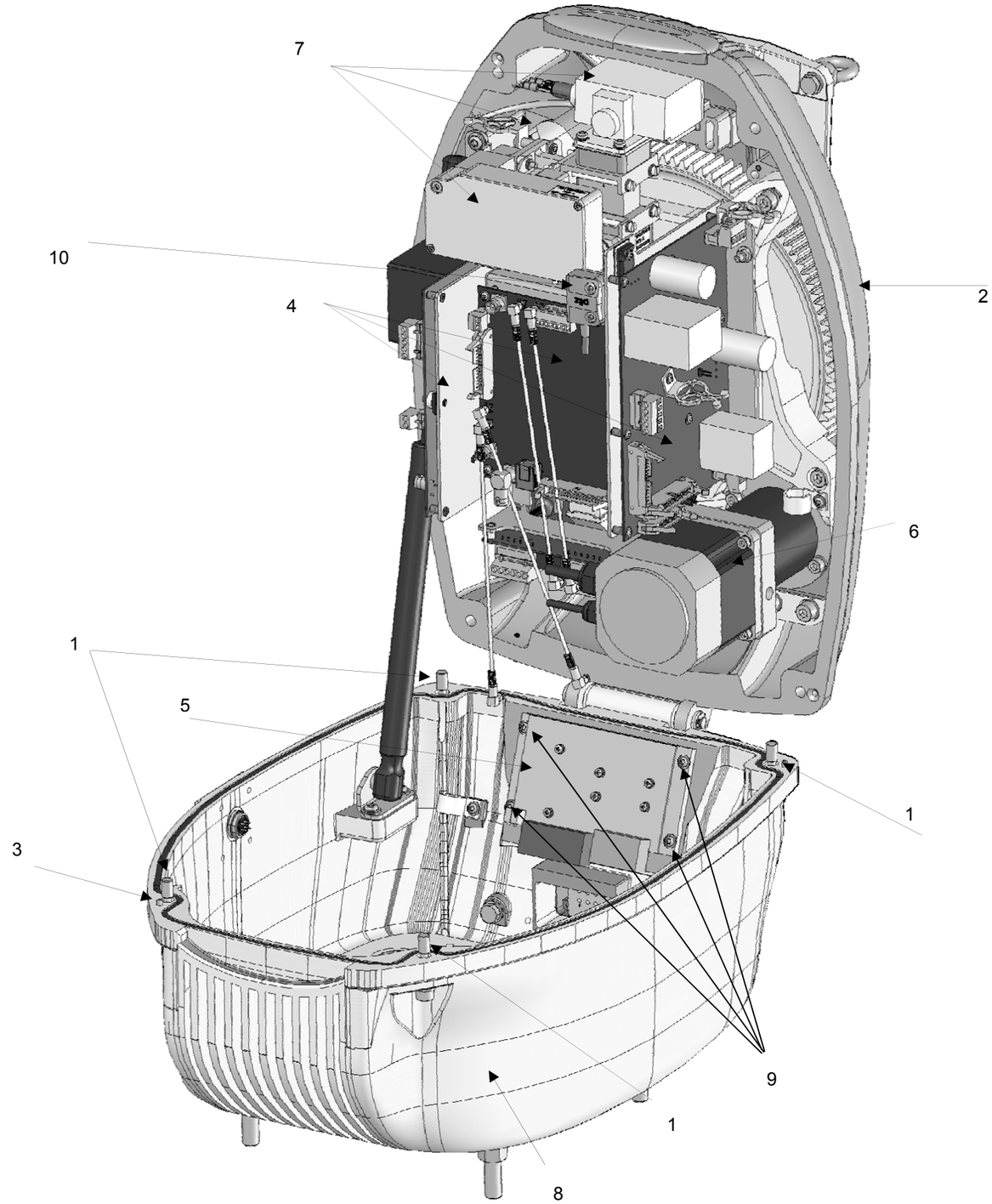
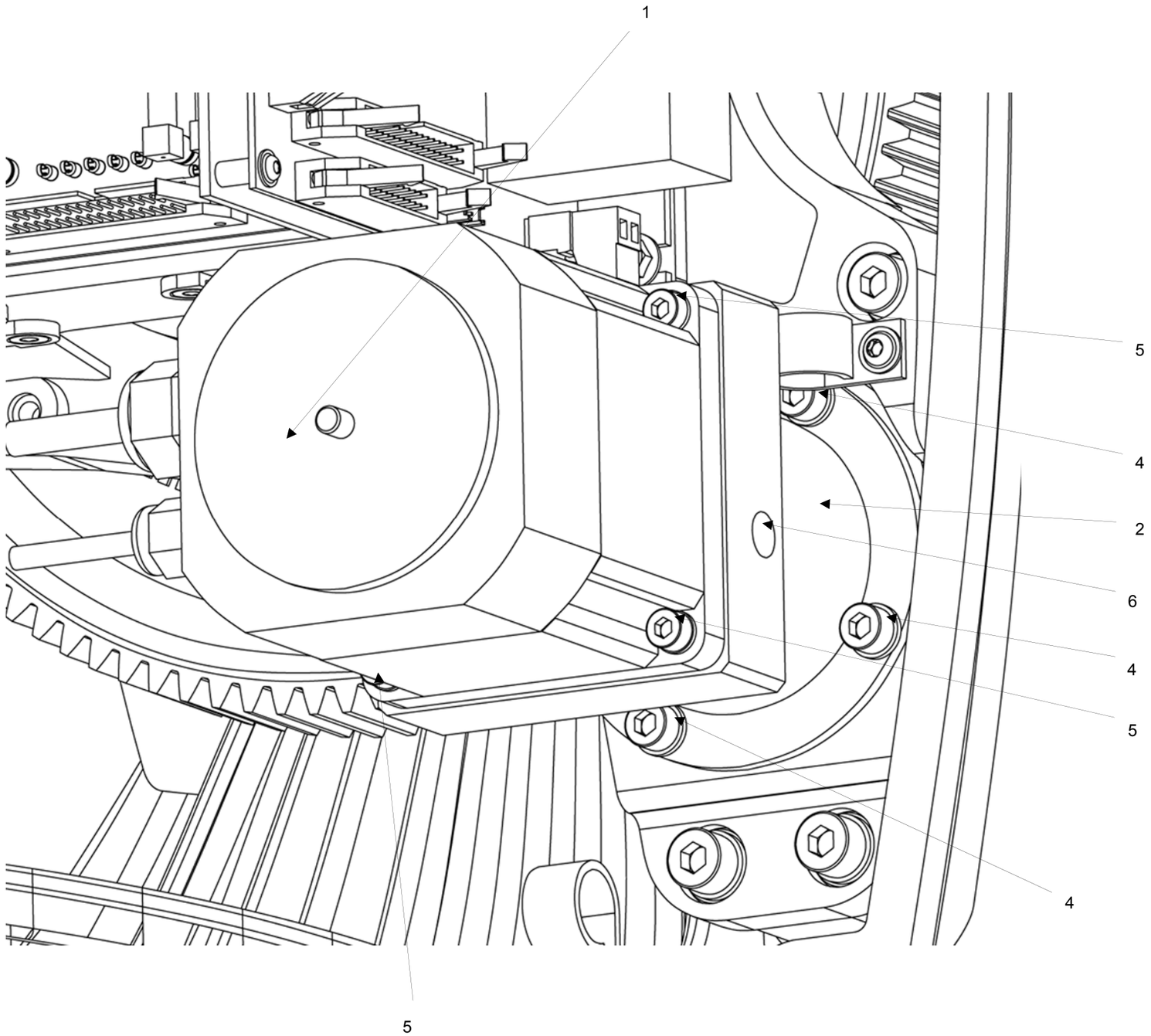


Figure 9.4 – SRT X-BAND RADAR SYSTEM internal view



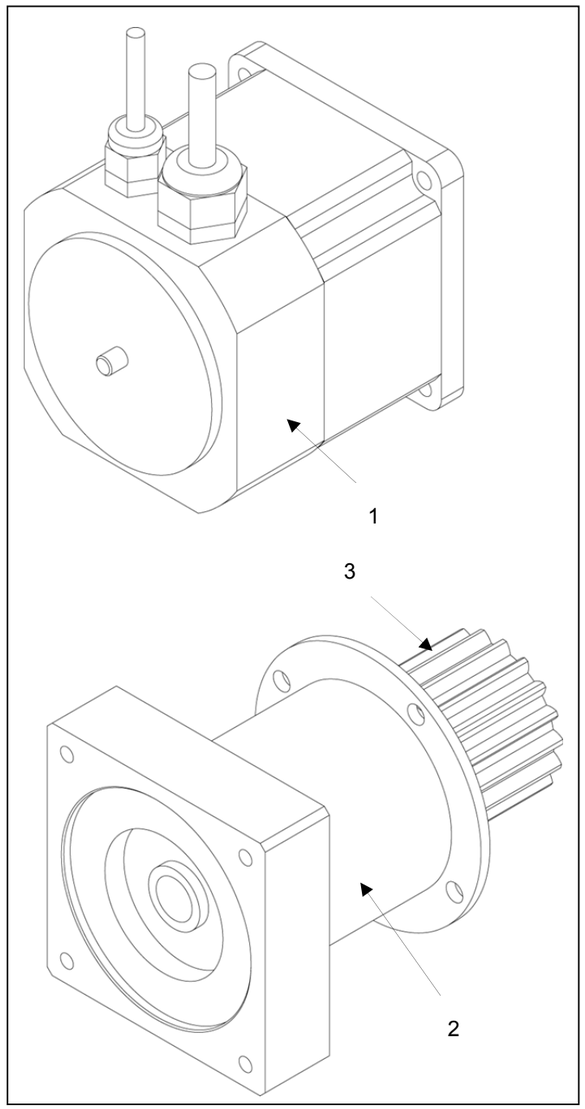
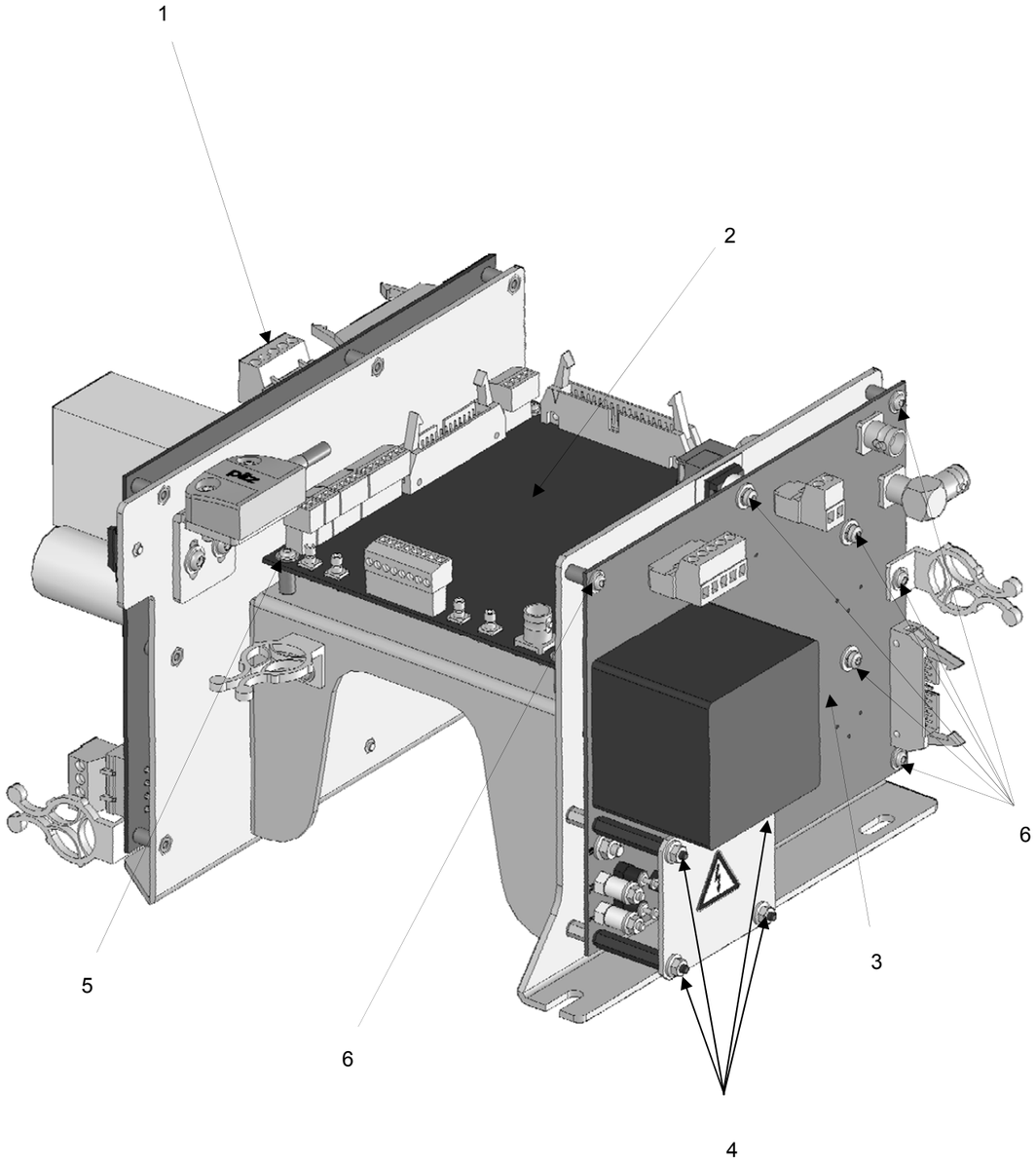


Figure 9.5 – Motorreducer assembly



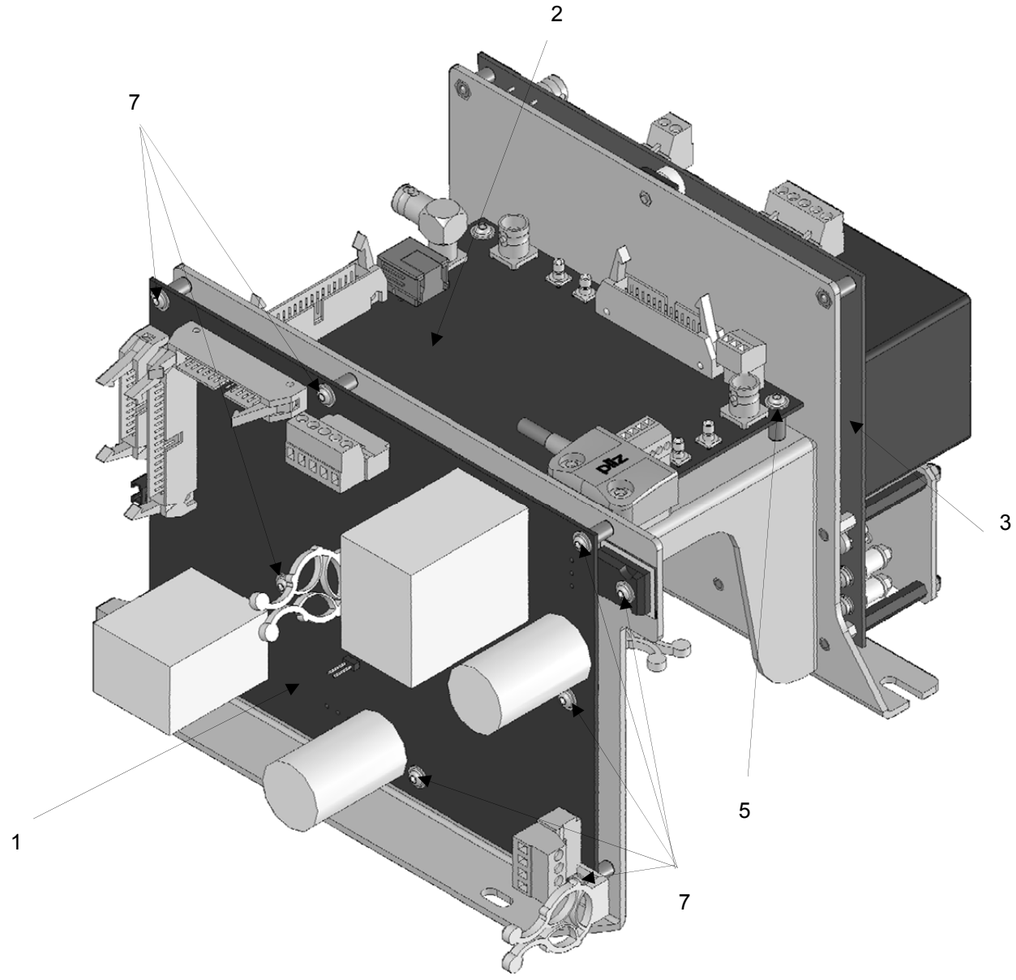


Figure 9.6 – Electronics rack

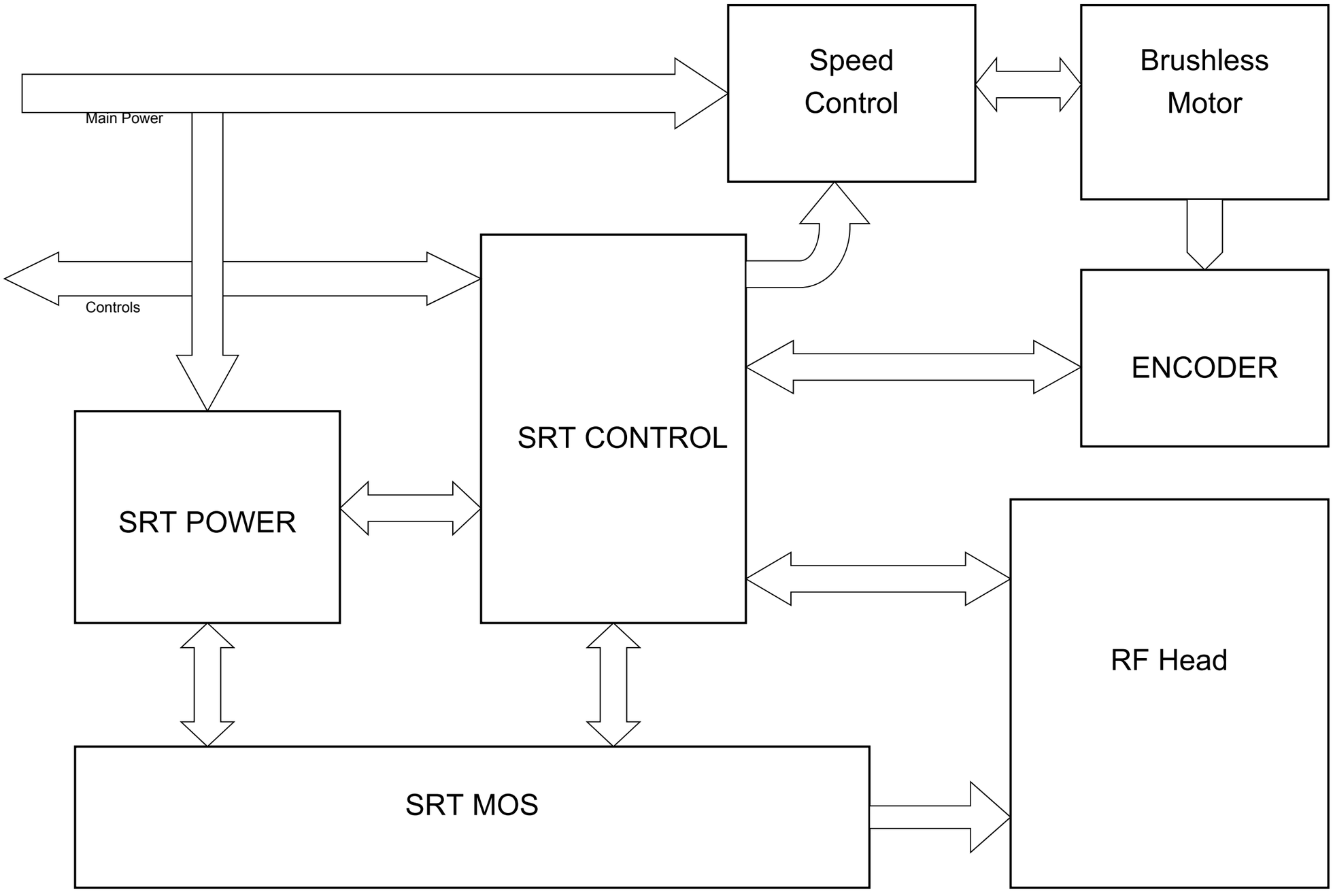


Figure 9.7 – SRT unit functional block diagram for 6 feet antenna

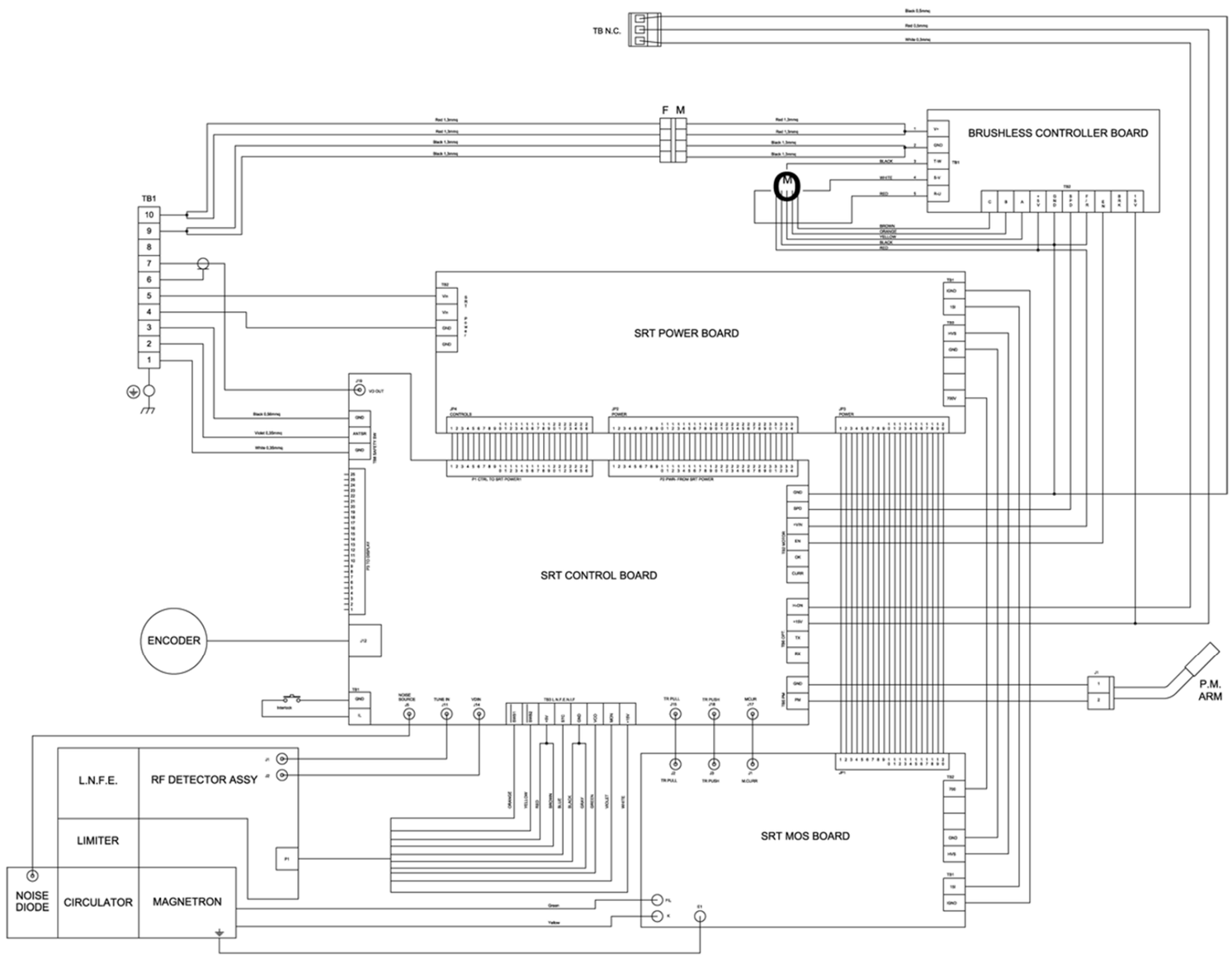


Figure 9.8 – SRT unit internal connection???

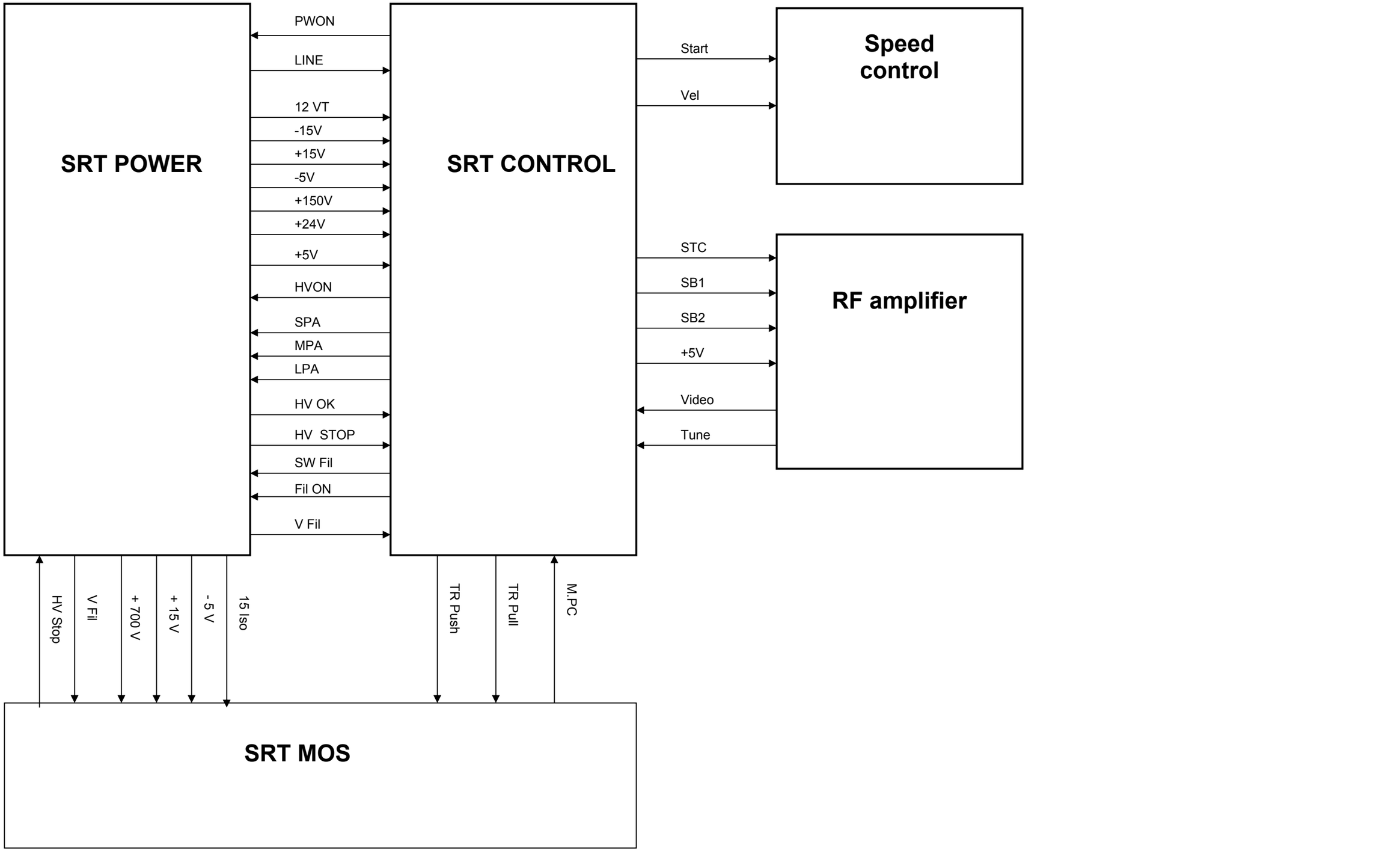


Figure 9.9 – SRT unit internal voltage and signals

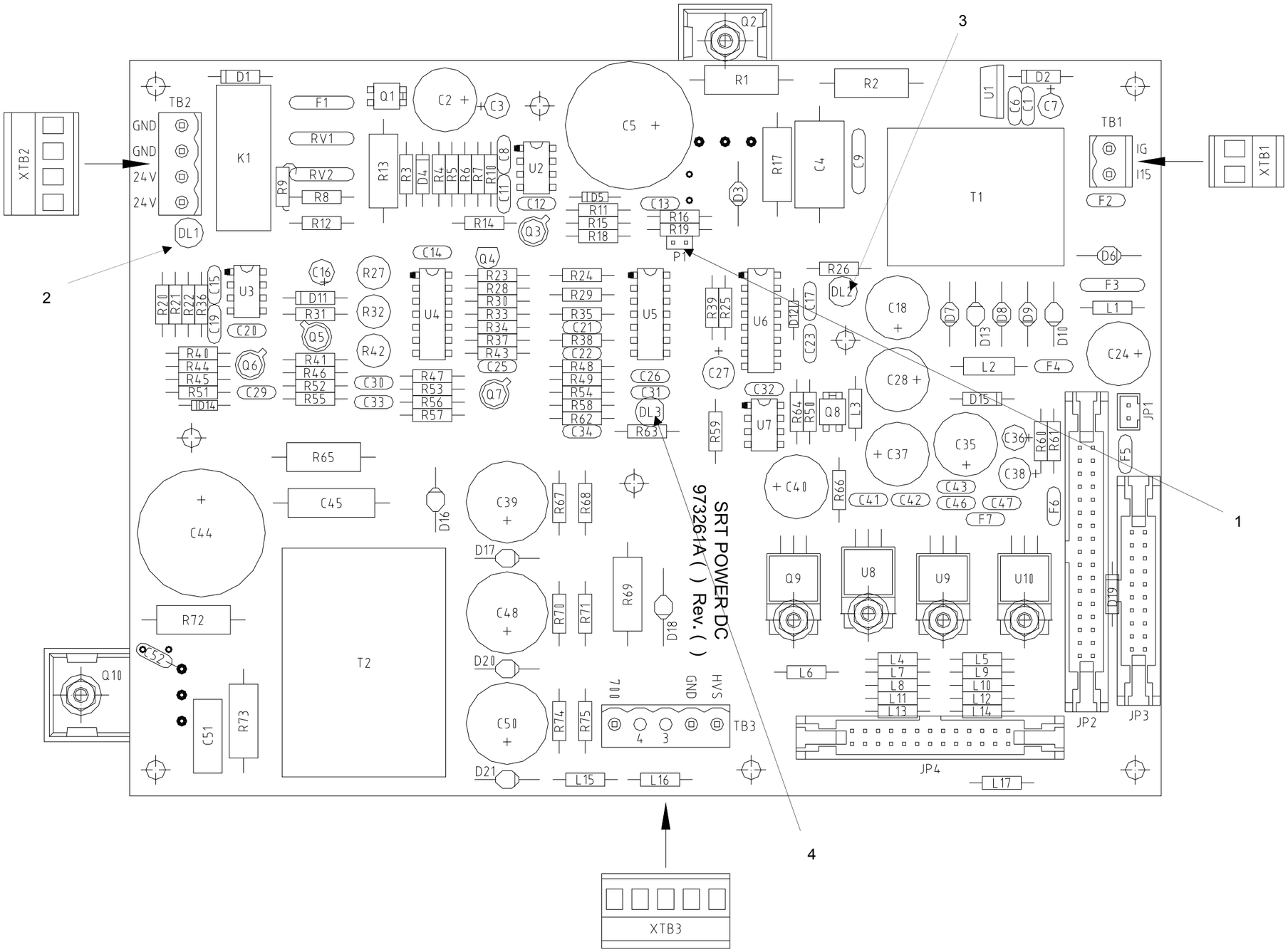


Figure 9.10 – SRT POWER board

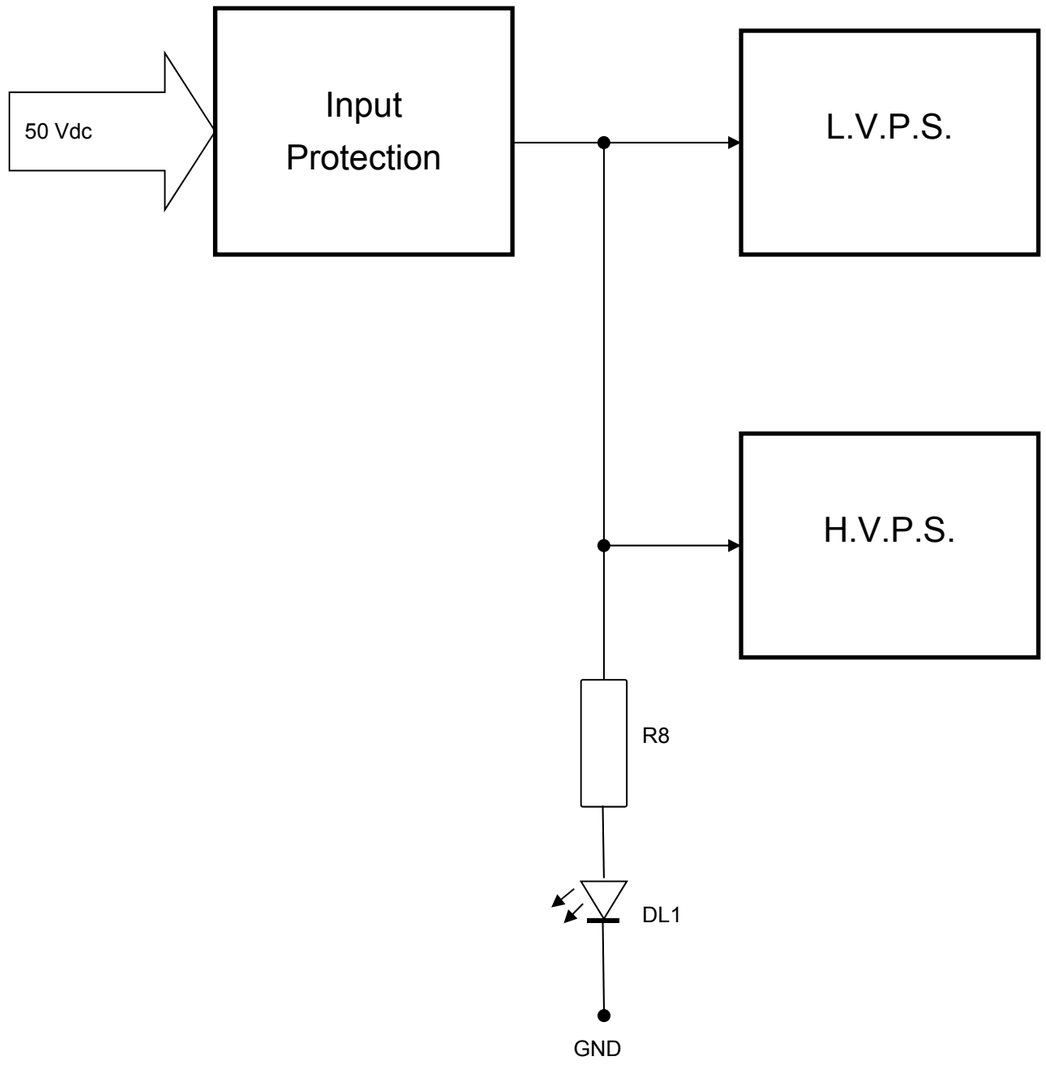


Figure 9.11 – SRT POWER board general block

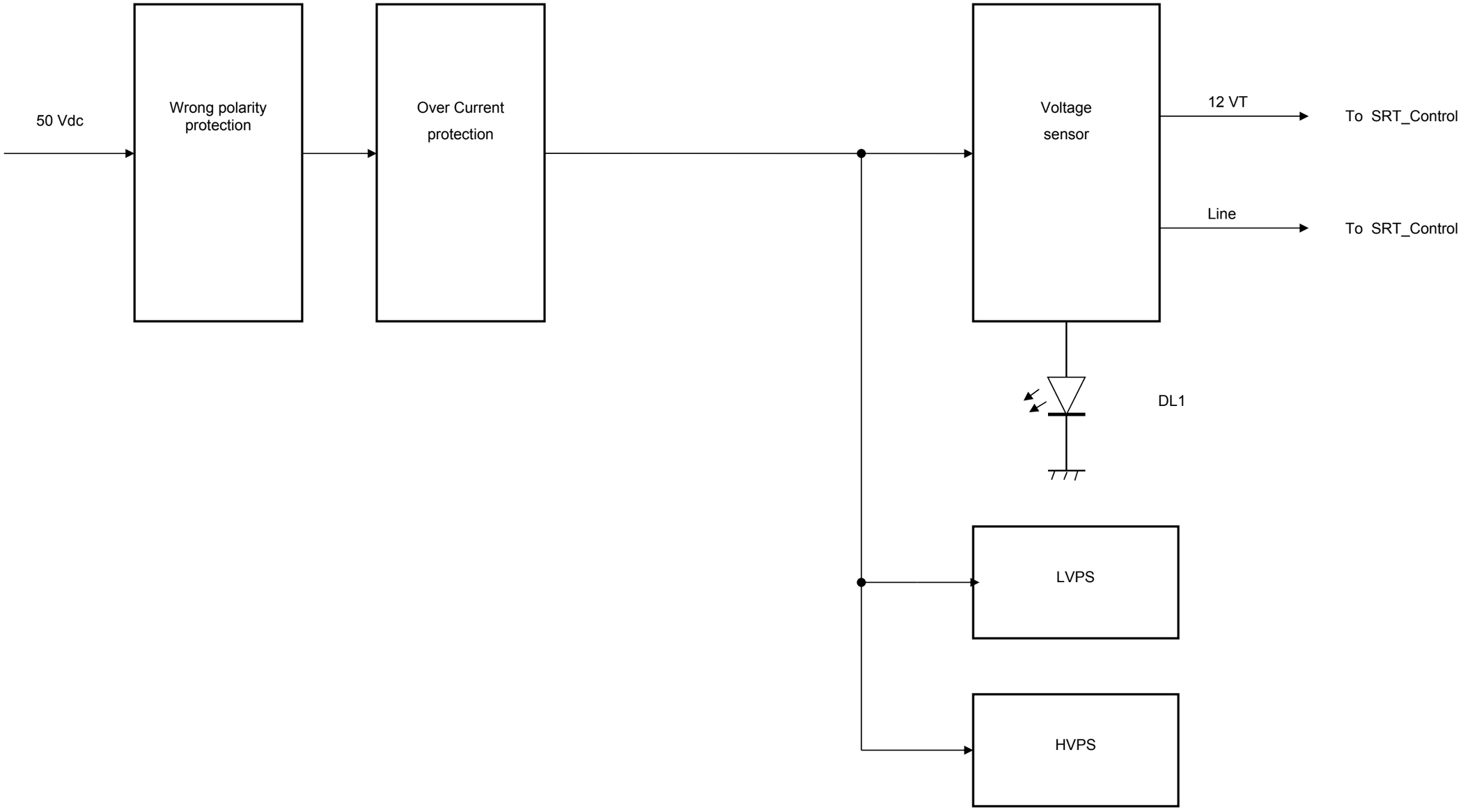


Figure 9.12 – SRT POWER board protection circuit

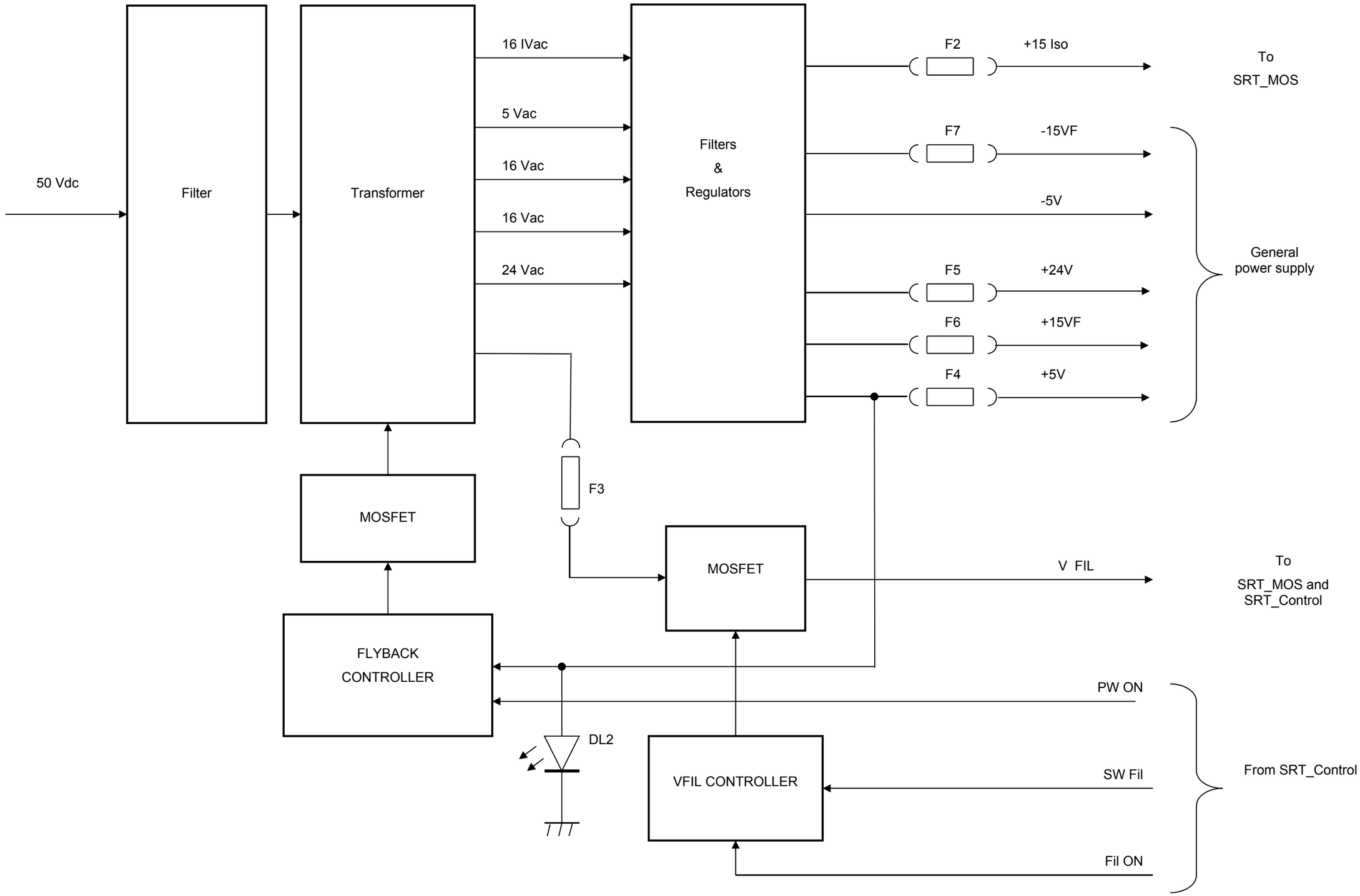


Figure 9.13 – SRT POWER board LVPS circuit

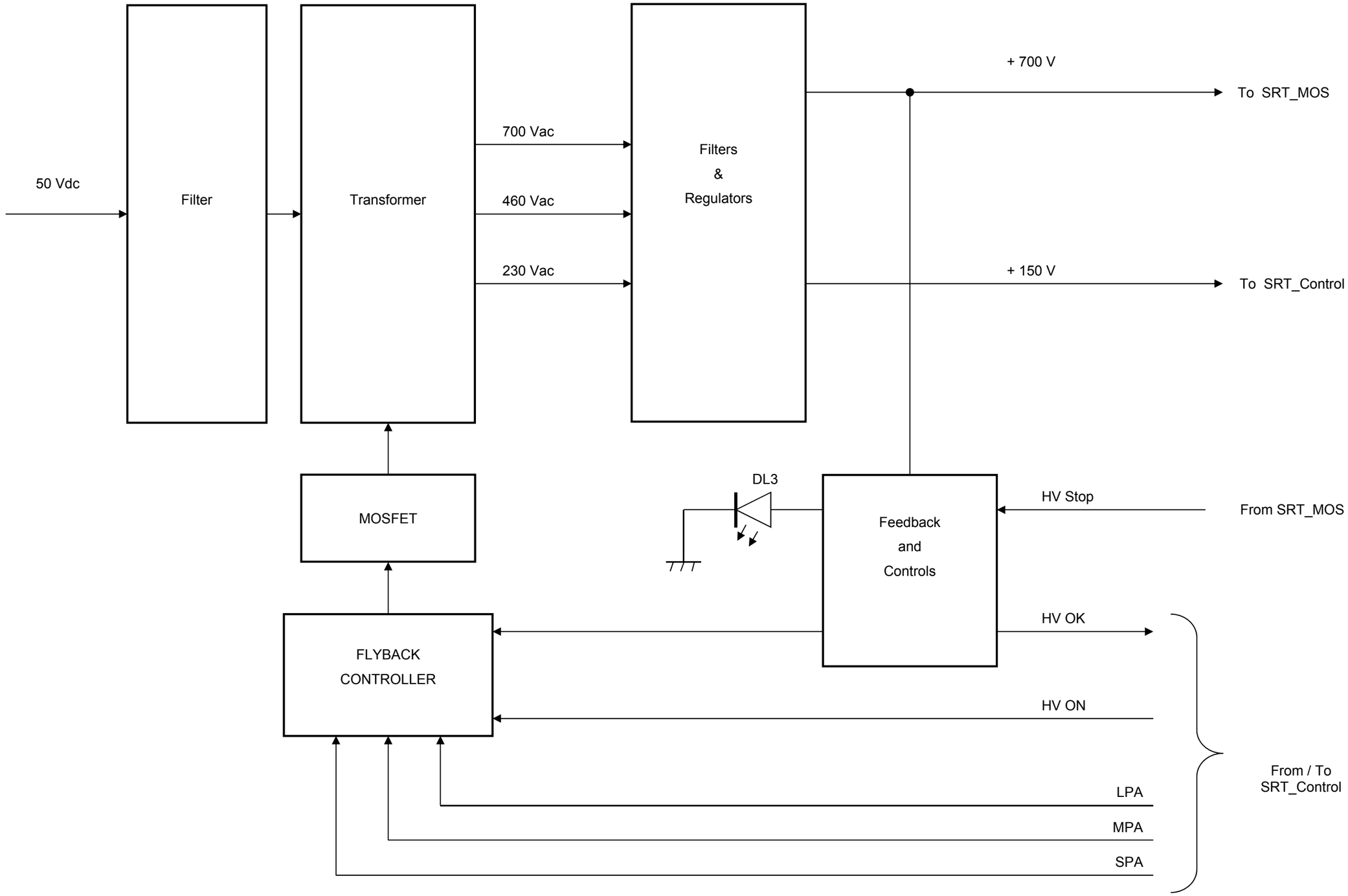


Figure 9.14 – SRT POWER board HVPS circuit

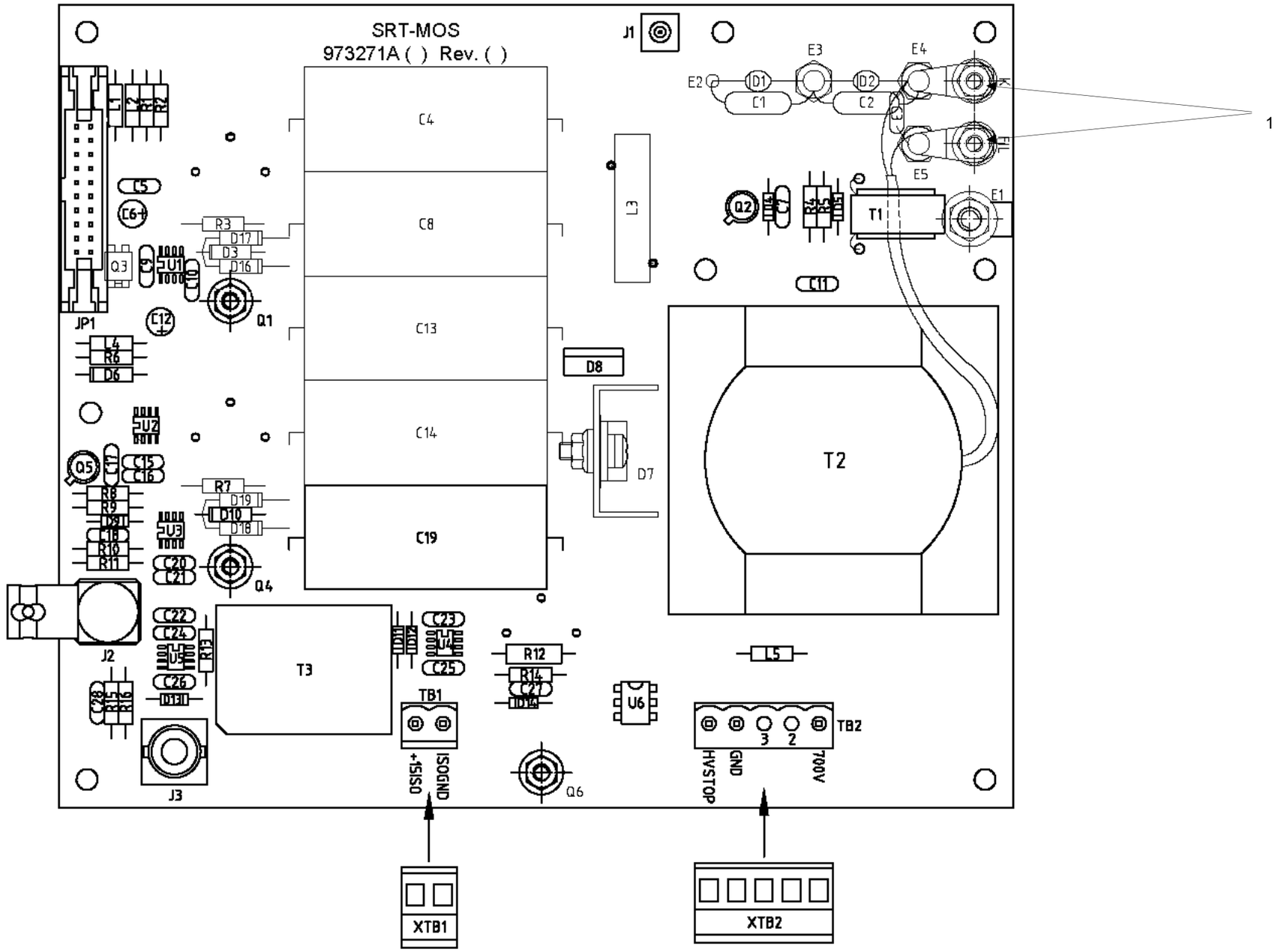


Figure 9.15 – SRT MOS board

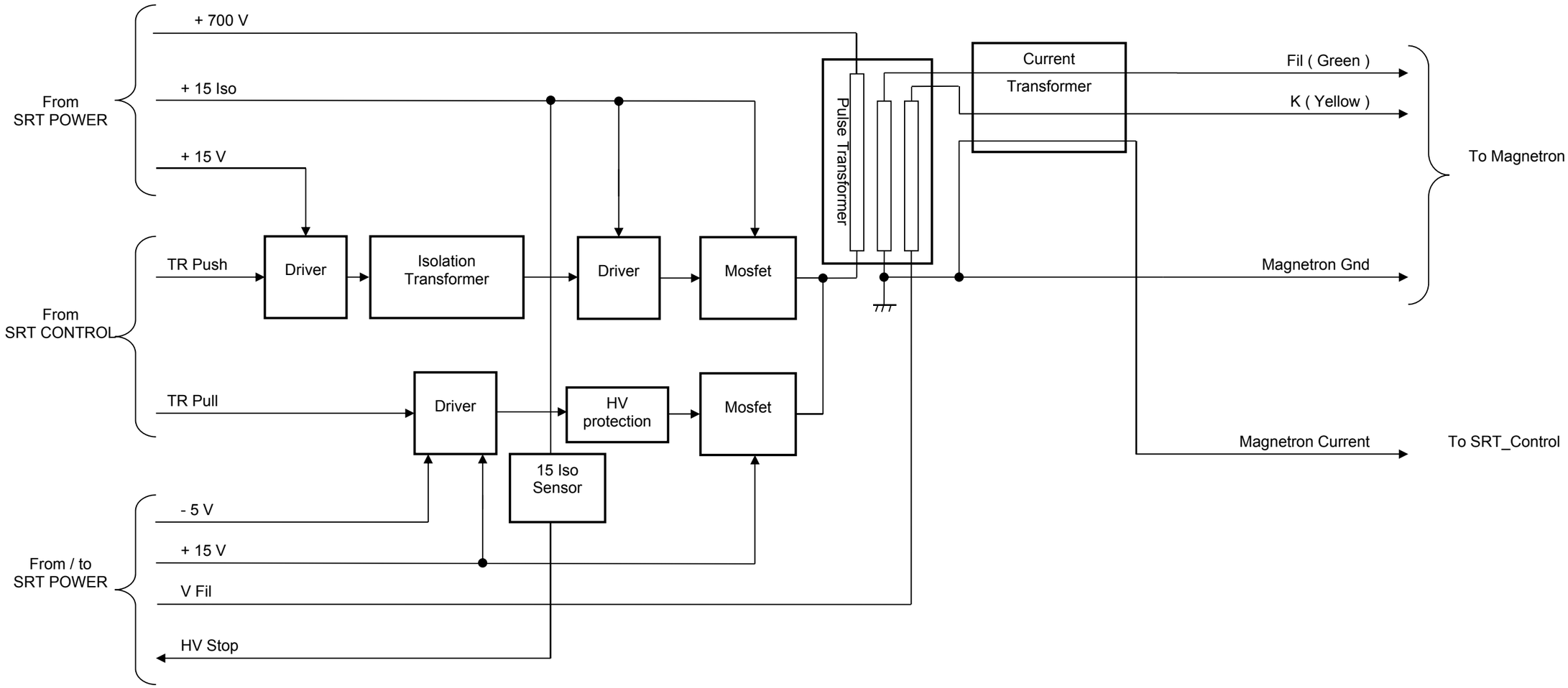


Figure 9.16 – SRT MOS board block diagram

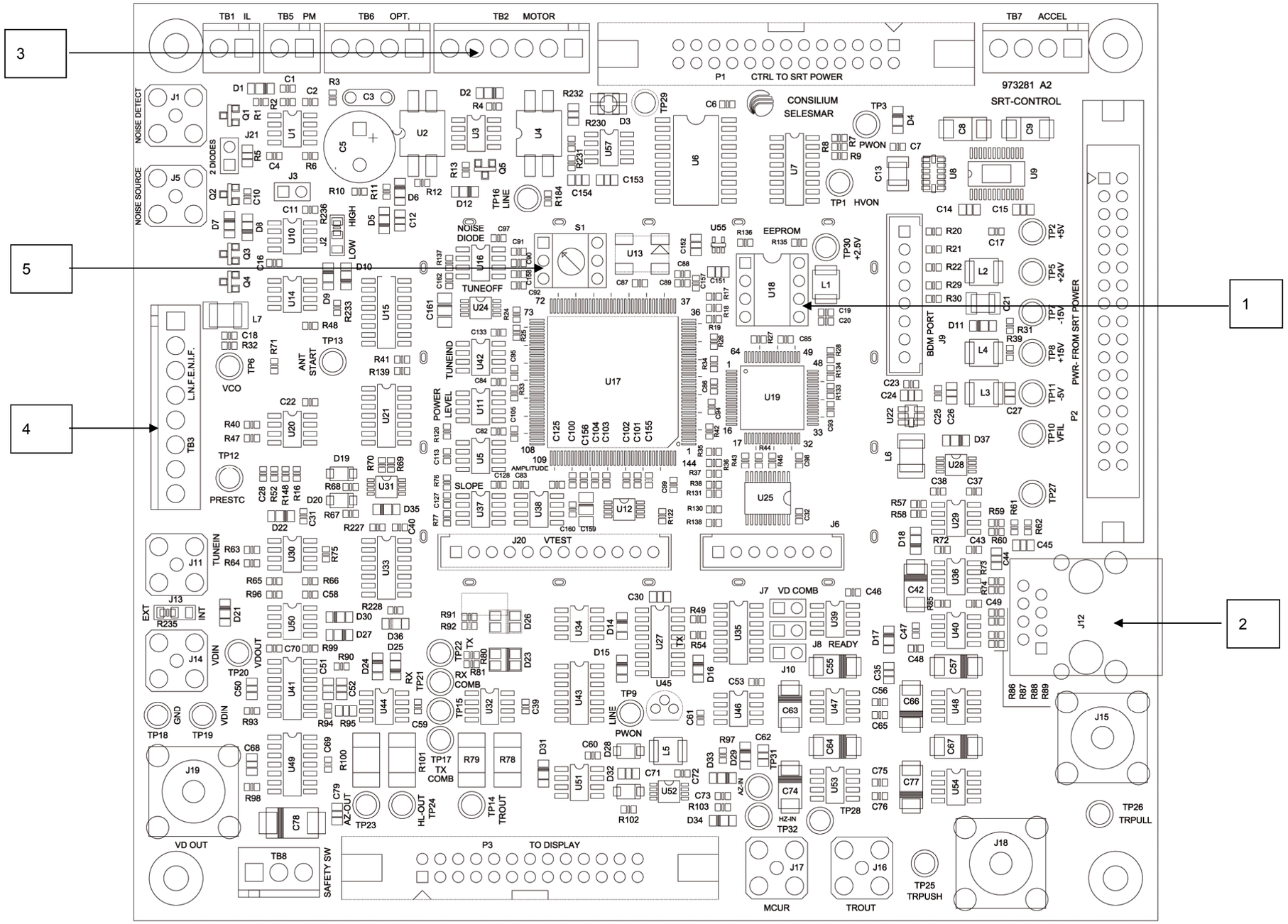


Figure 9.17 – SRT CONTROL board block diagram

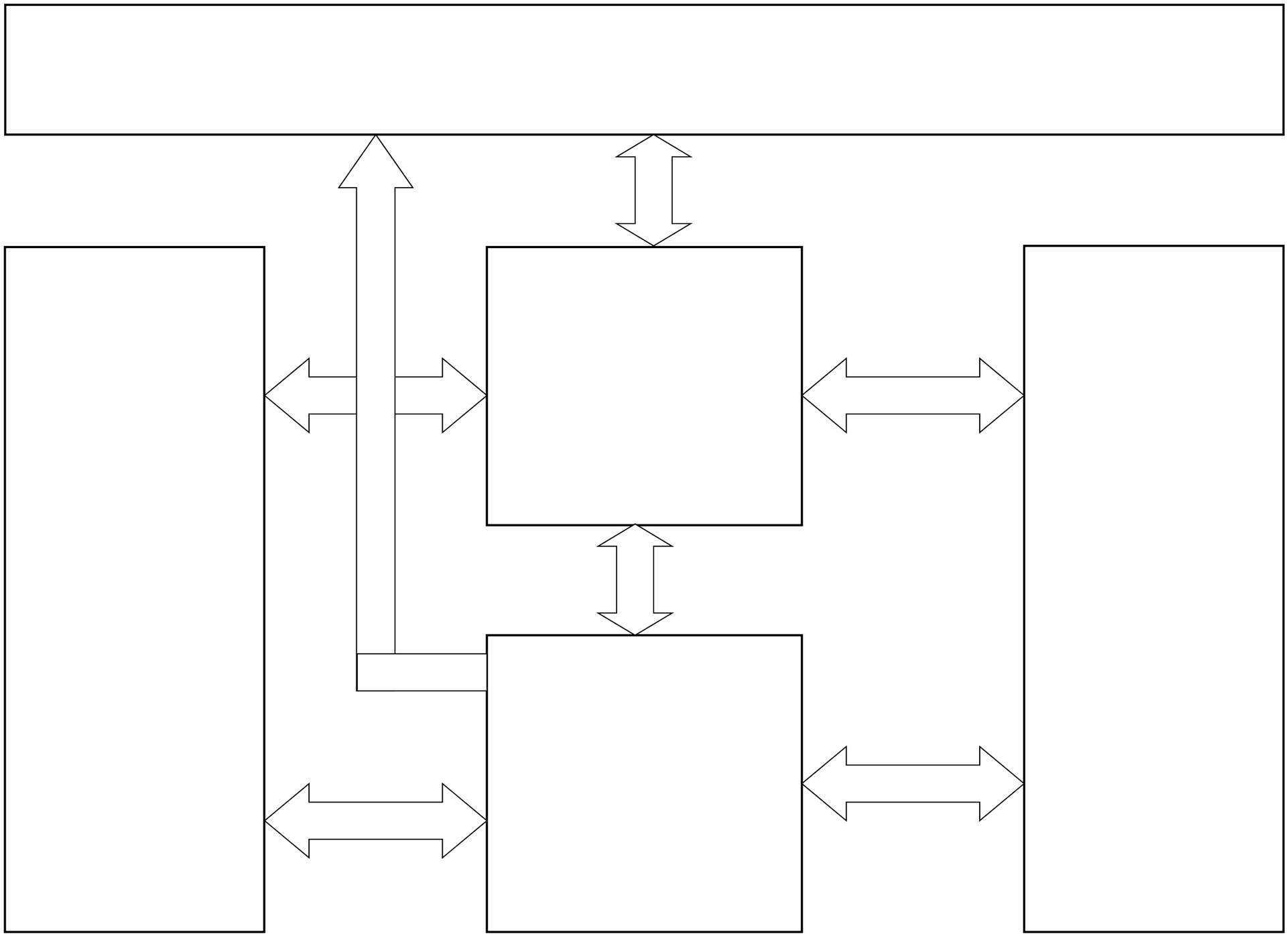


Figure 9.18 – SRT CONTROL board internal block

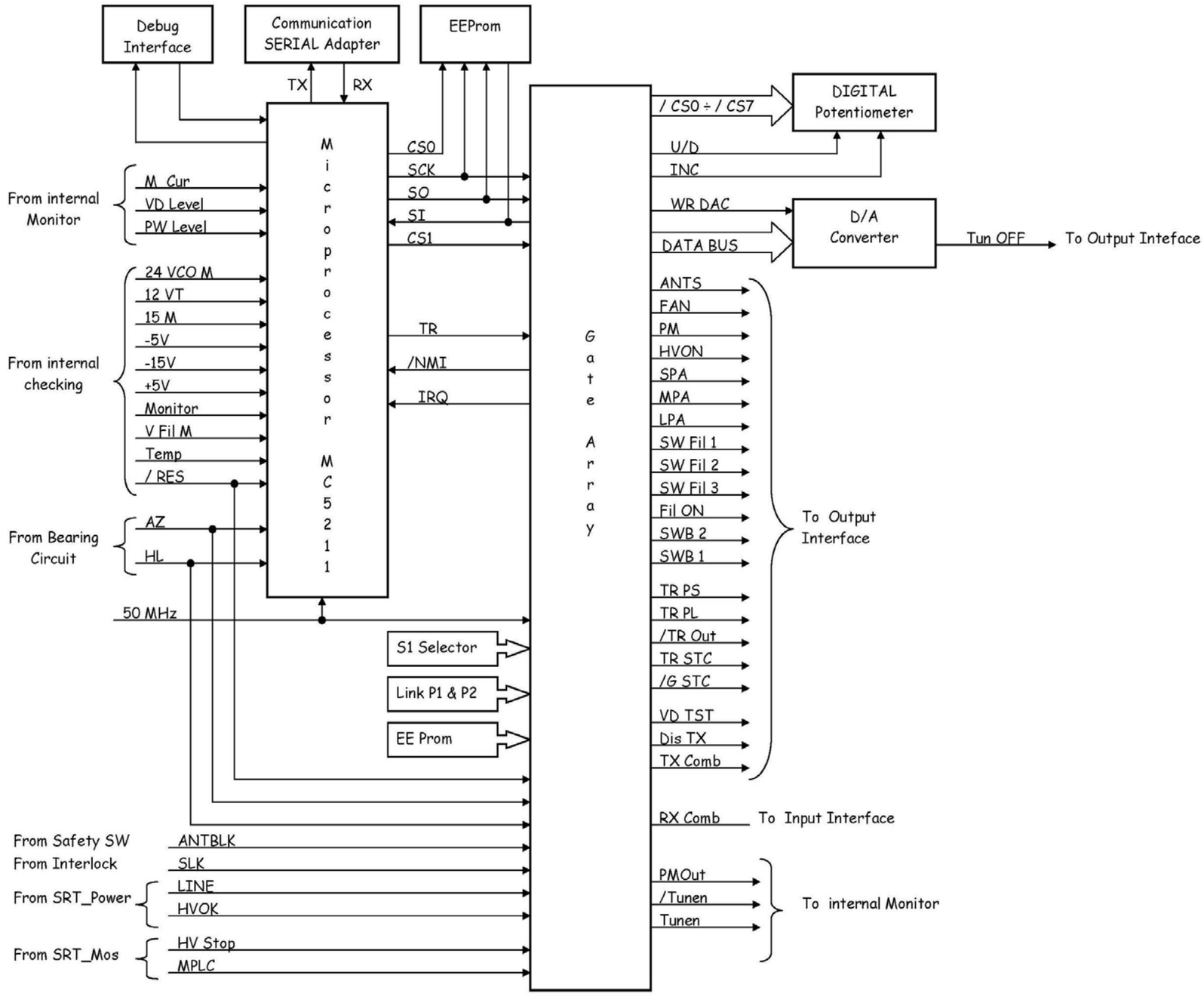


Figure 9.19 – SRT CONTROL board microprocessor and gate array

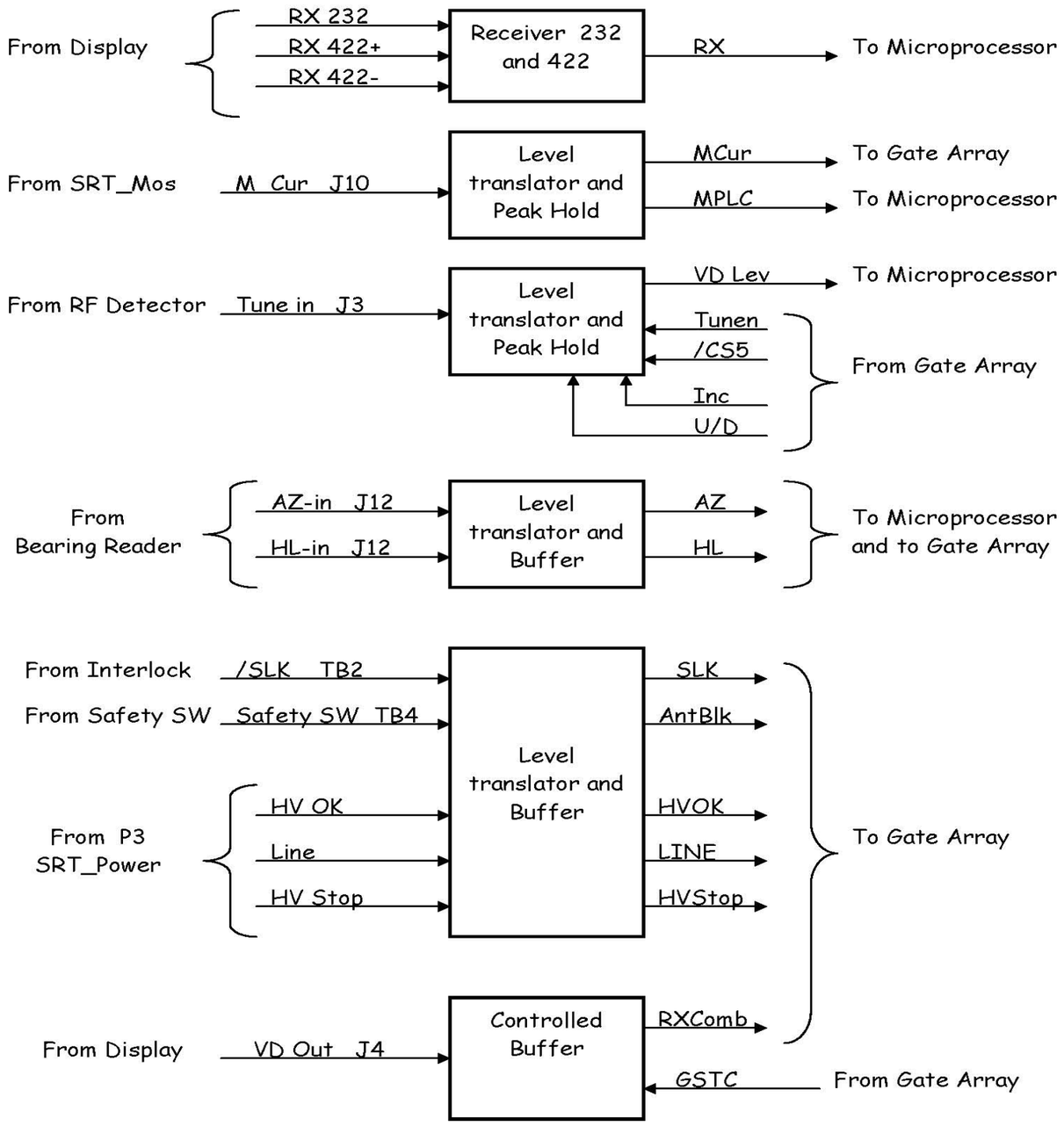


Figure 9.20 – SRT CONTROL board input interface

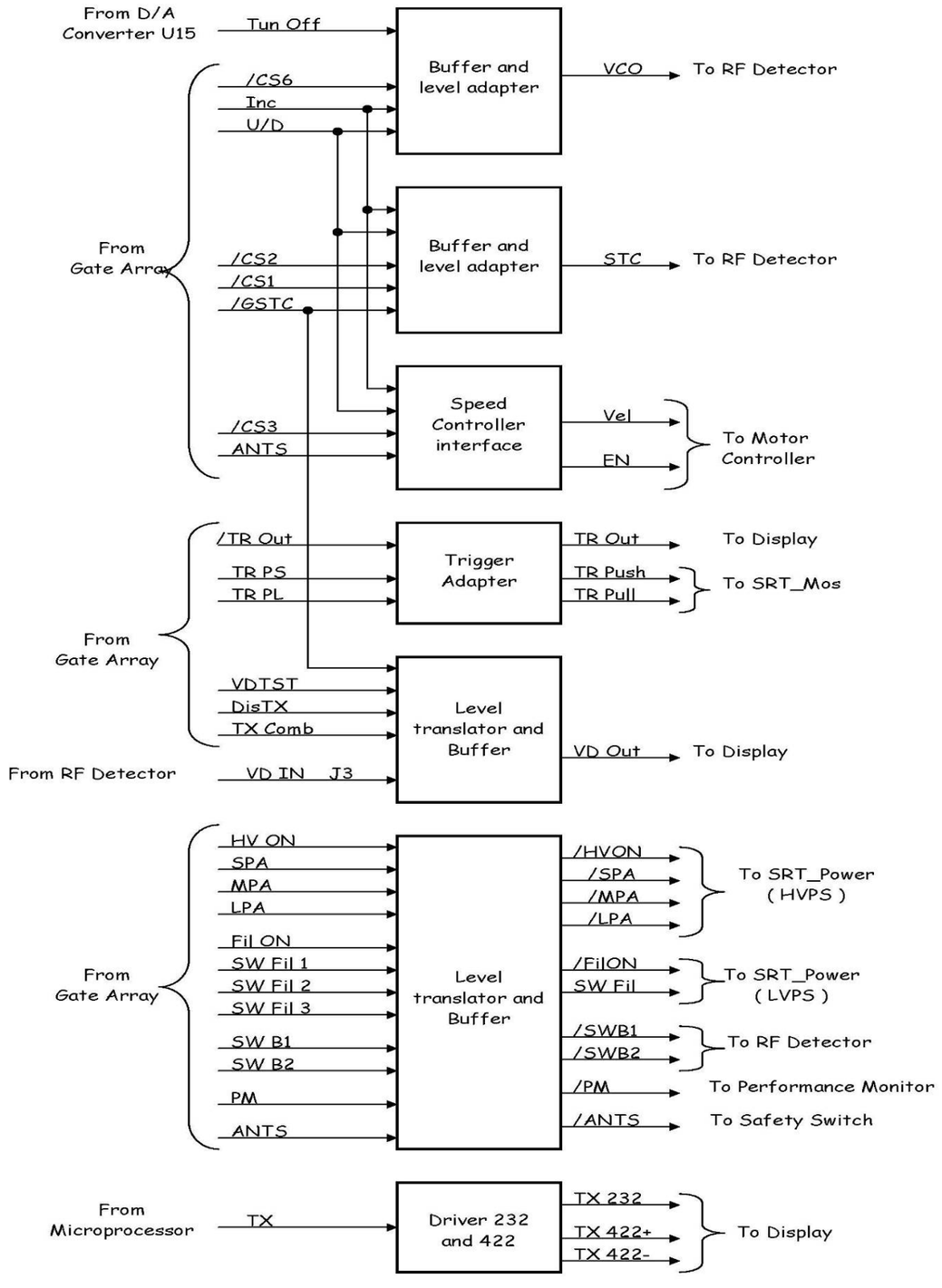


Figure 9.21 – SRT CONTROL board output interface

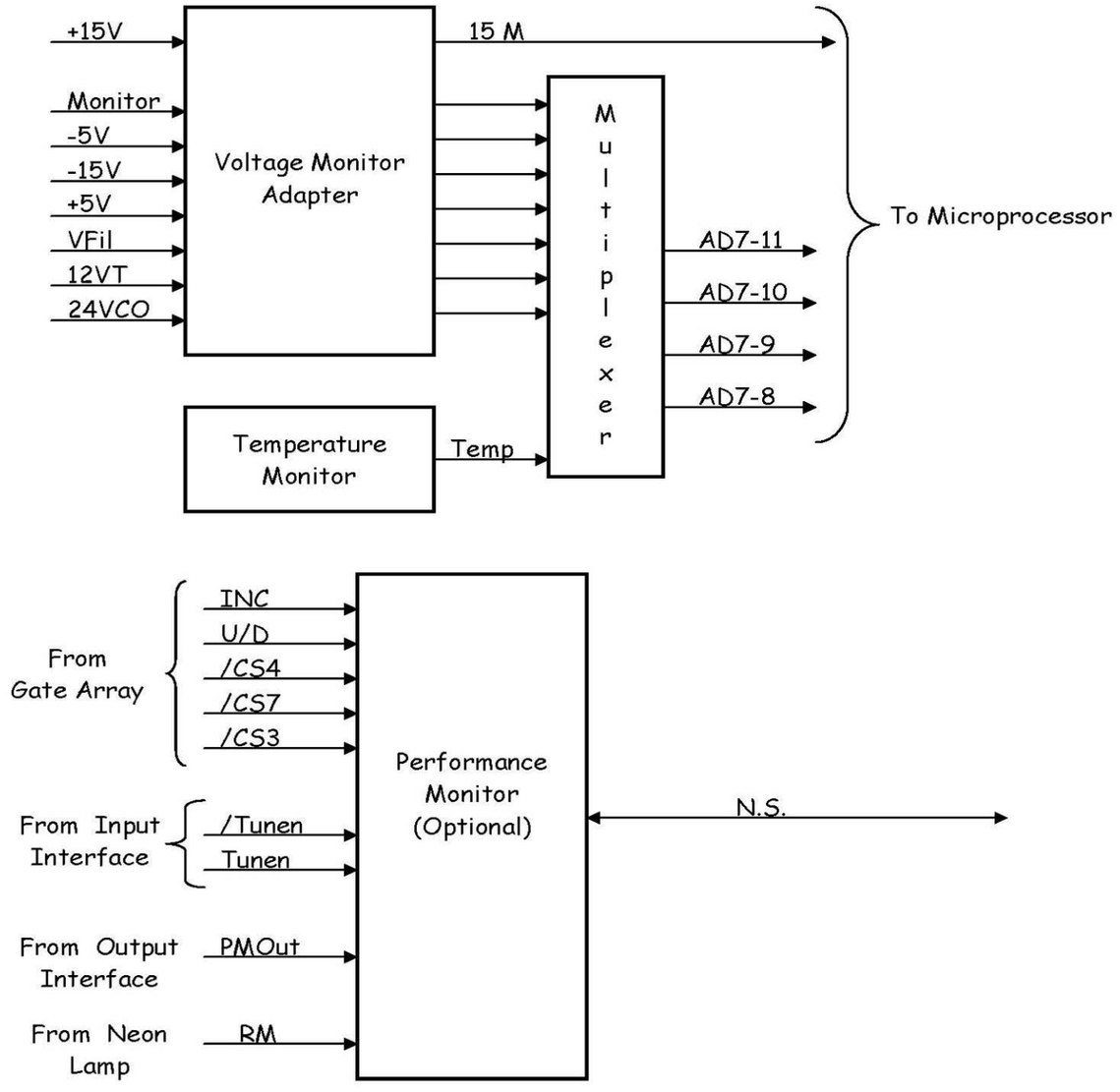


Figure 9.22 – SRT CONROL board monitor

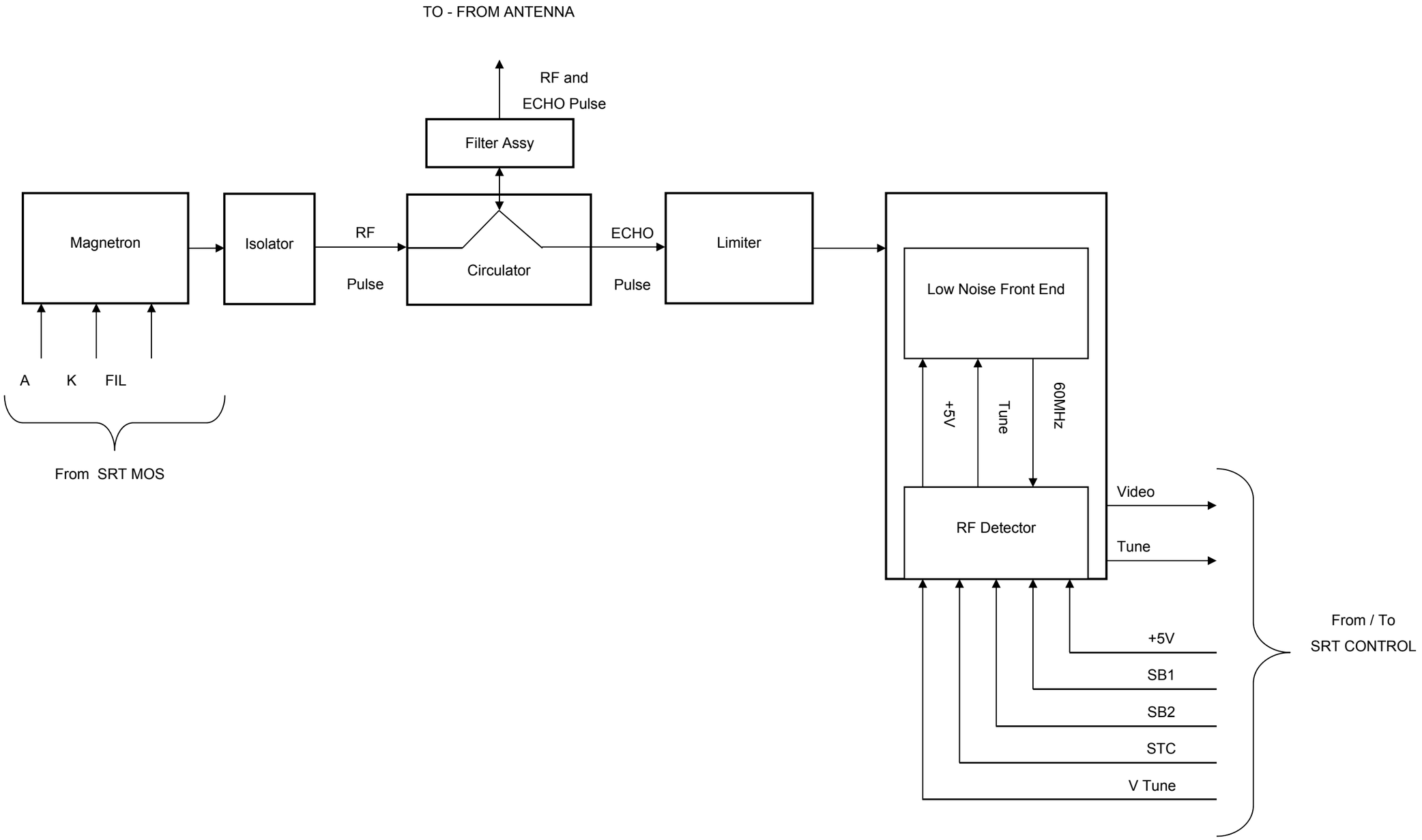


Figure 9.23 – RF Head functional block diagram

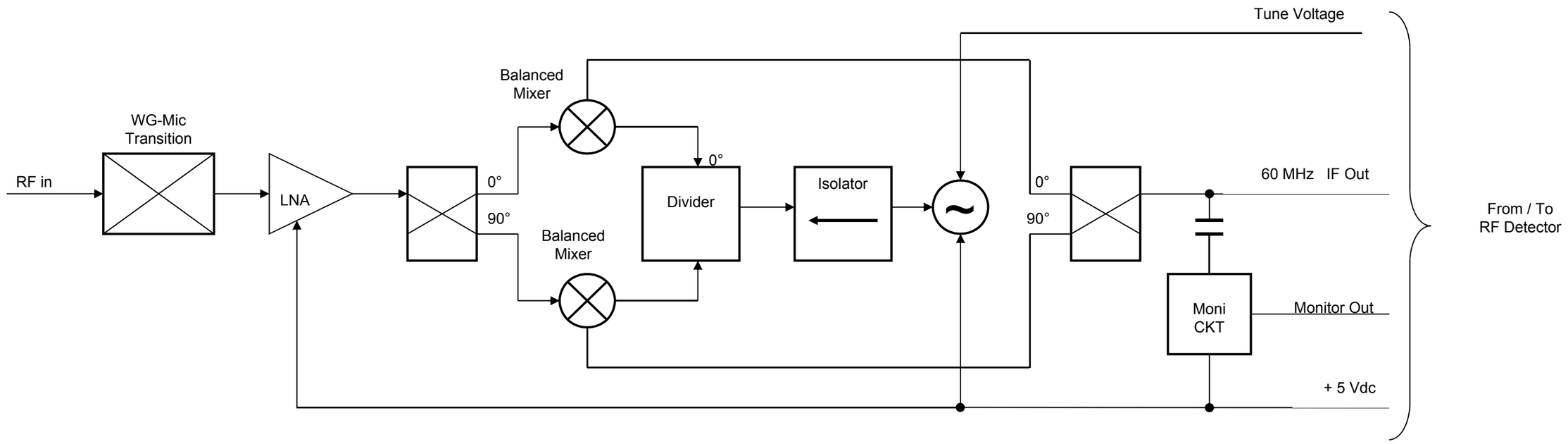


Figure 9.24 – RF Head, LNFE block diagram

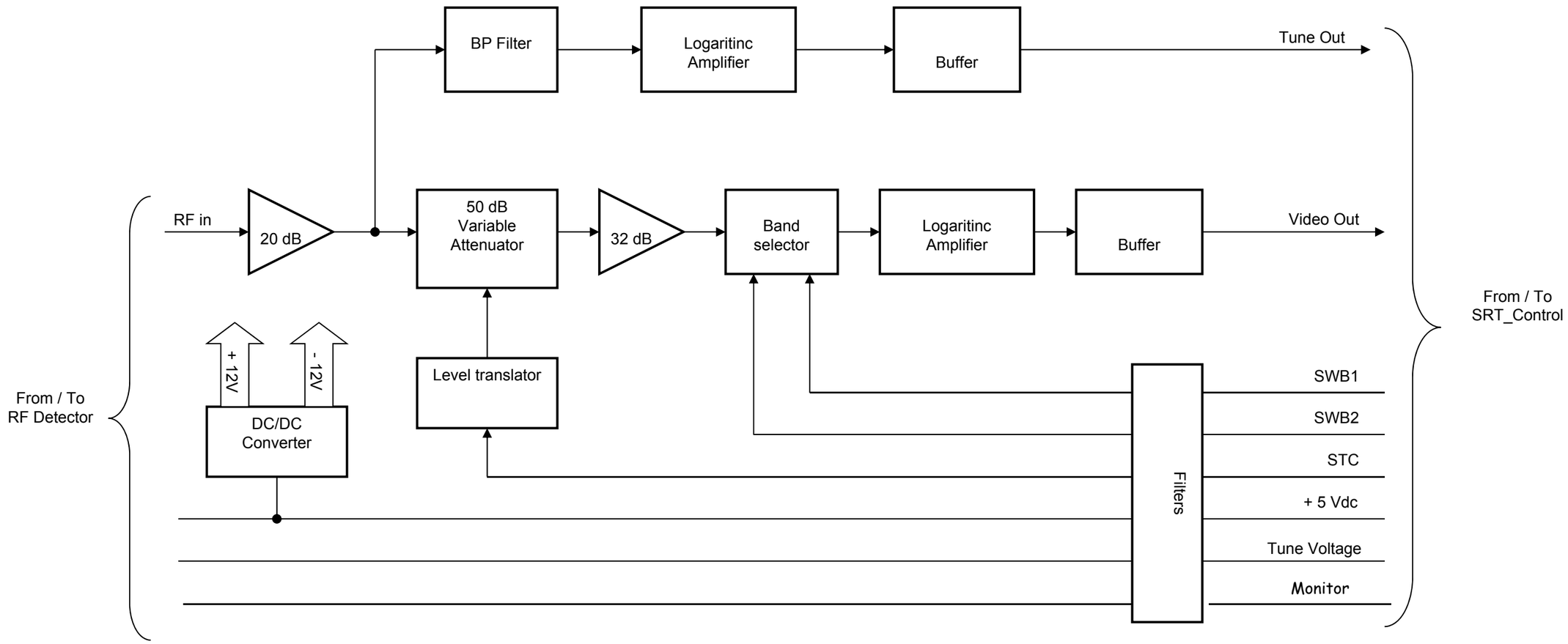


Figure 9.25 – RF Head, RF DETECTOR block diagram

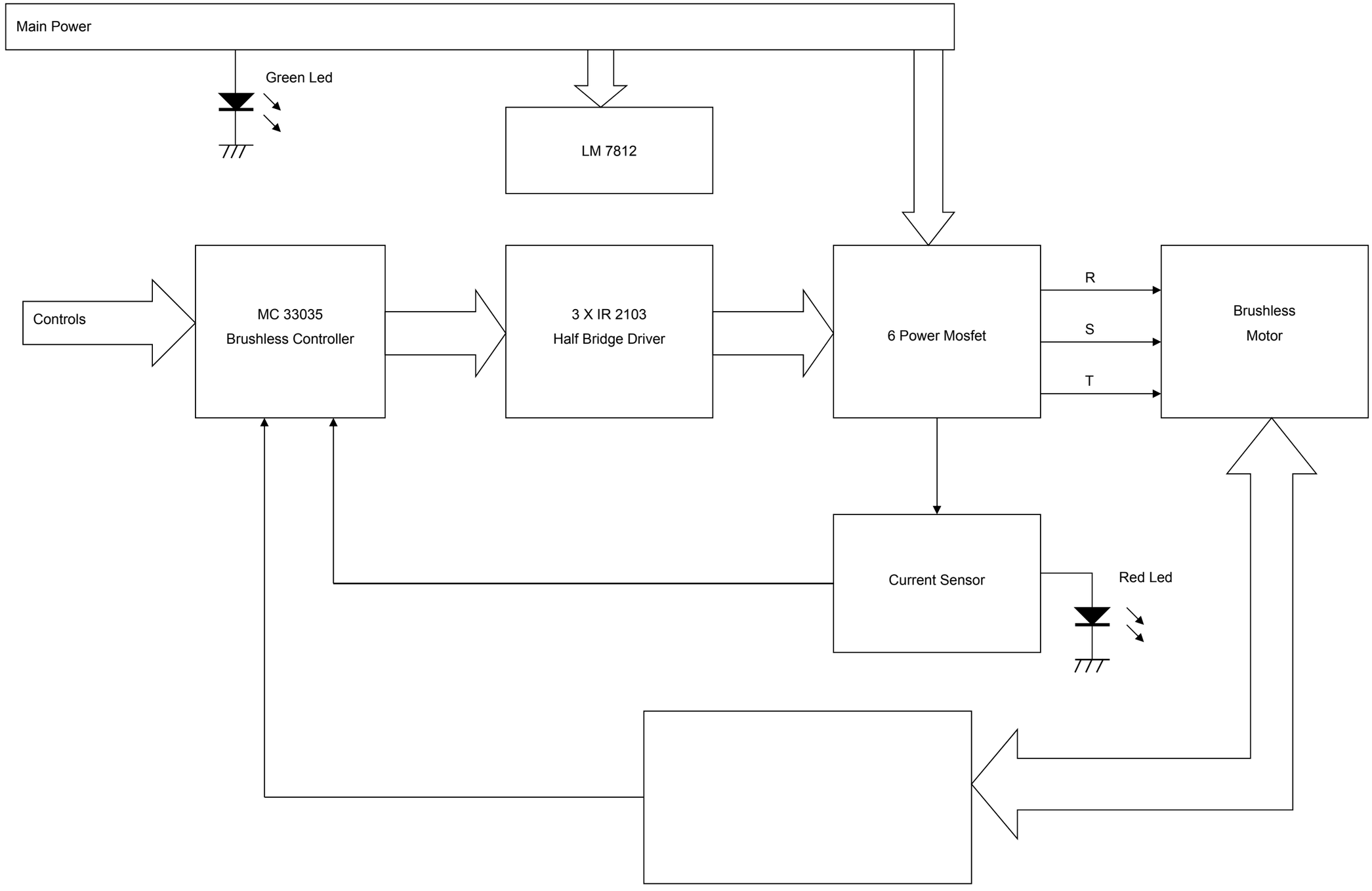


Figure 9.26 – Brushless controller functional block diagram

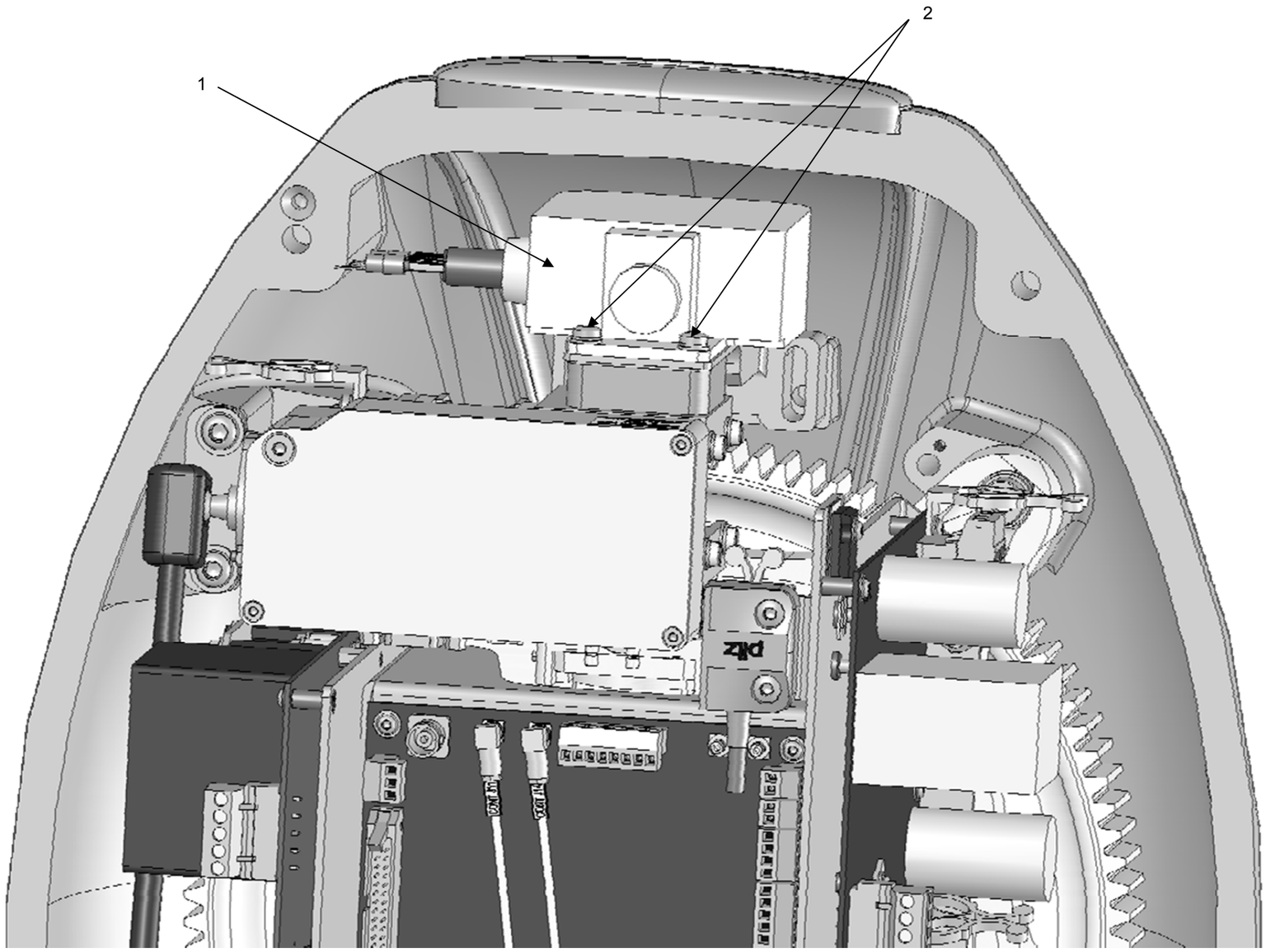


Figure 9.27 – Electronic rack, RF Head particular

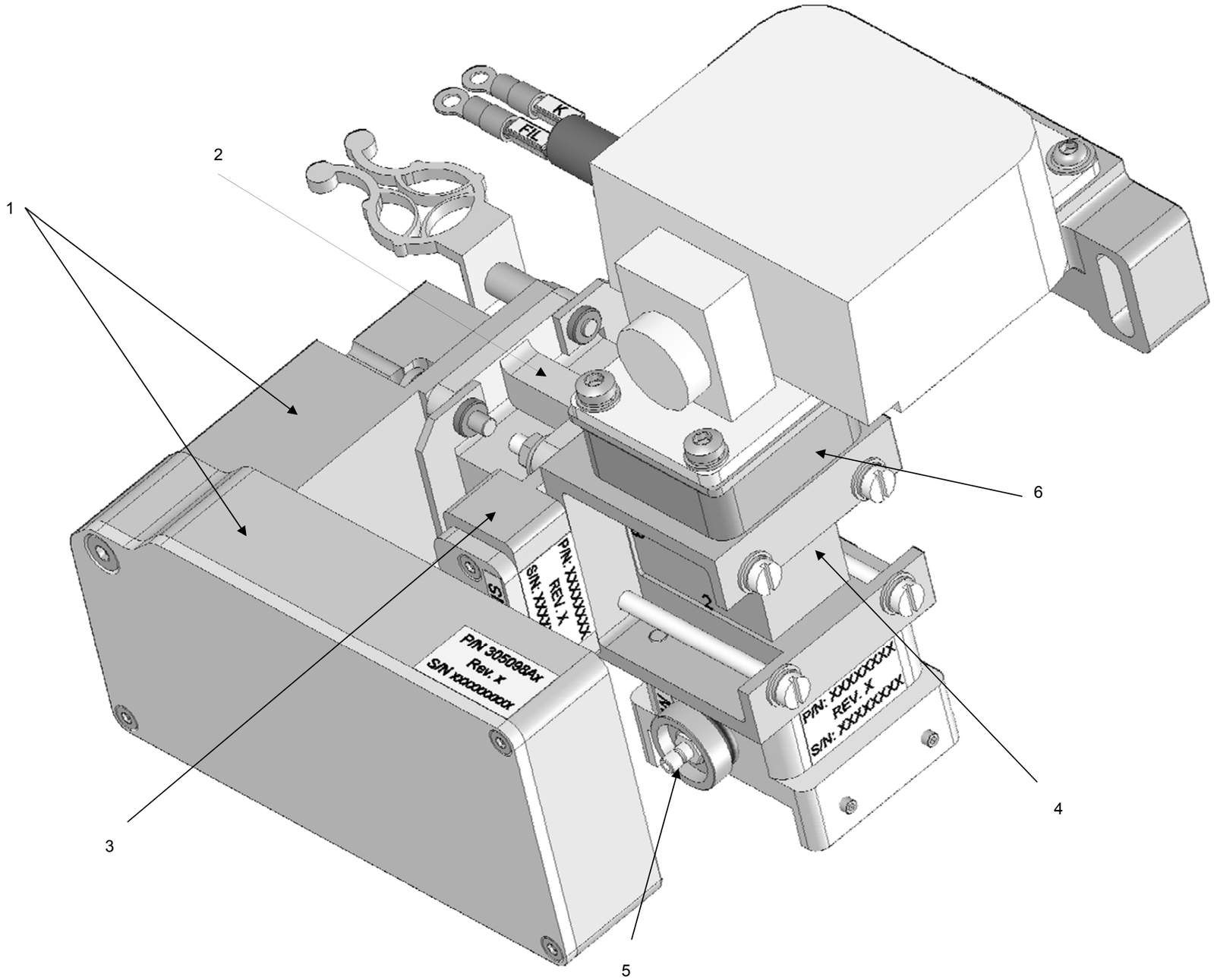


Figure 9.28 – RF Head view

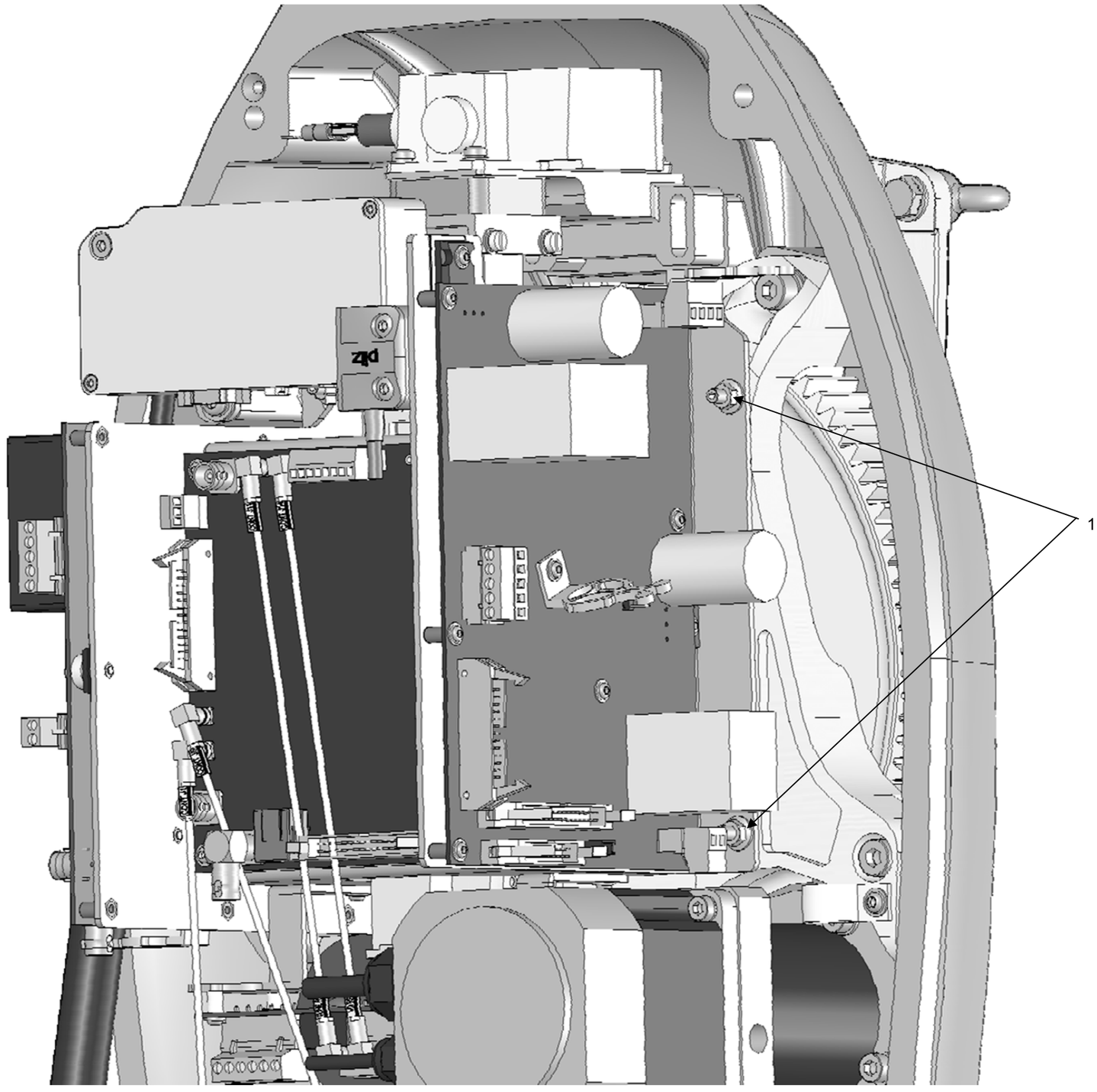


Figure 9.29 – Electronic rack view

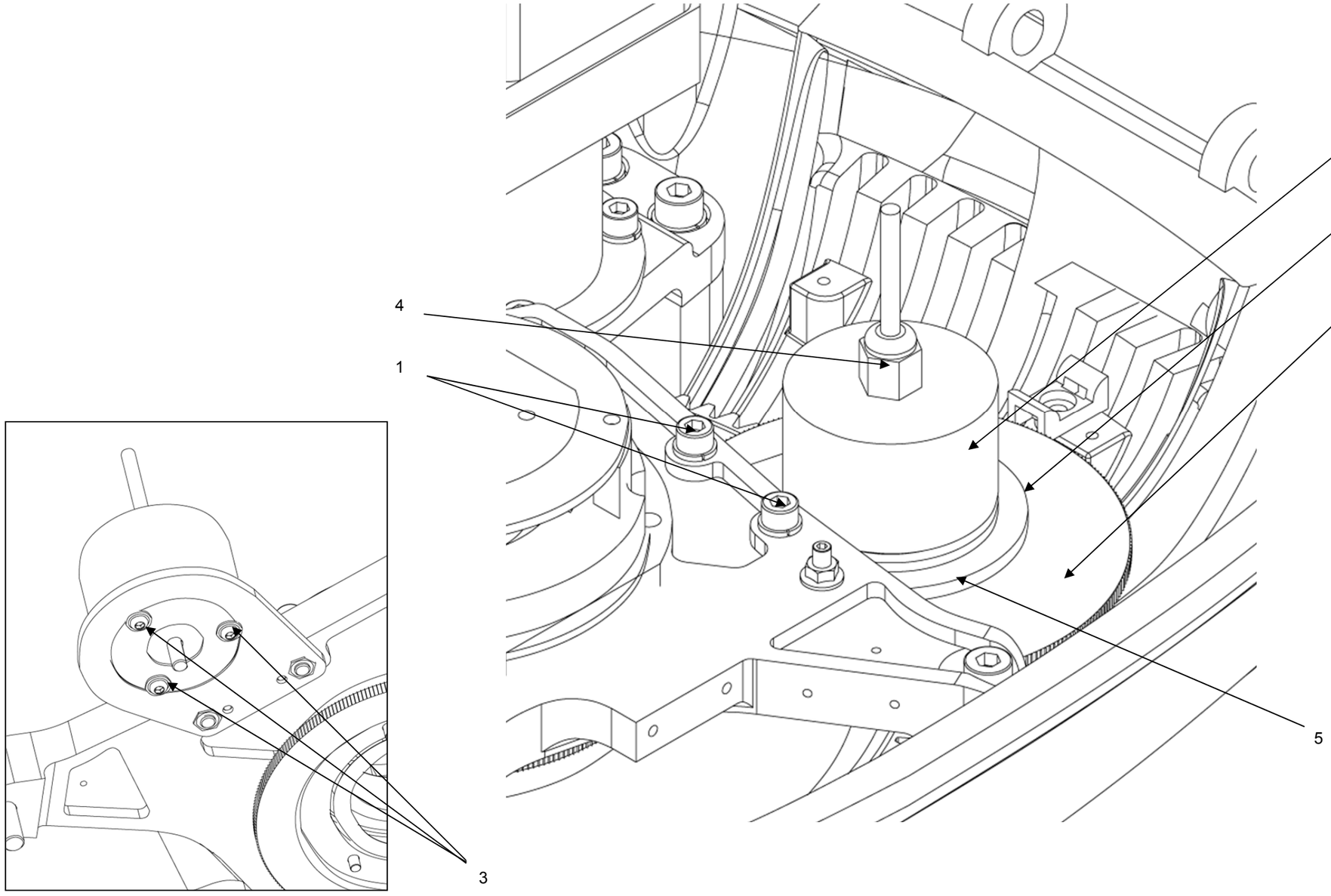


Figure 9.30 – Encoder view

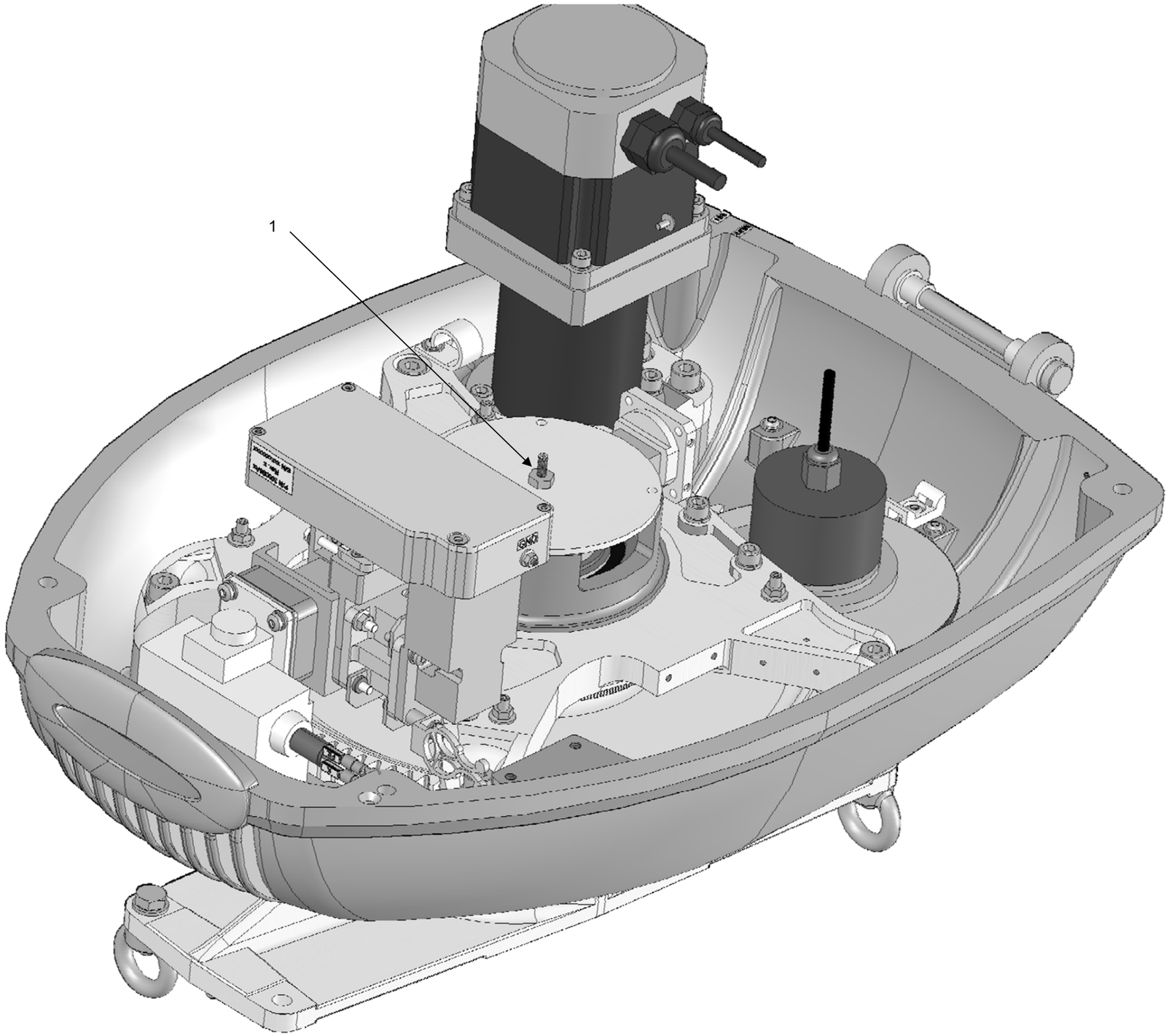


Figure 9.31 – Rotary joint

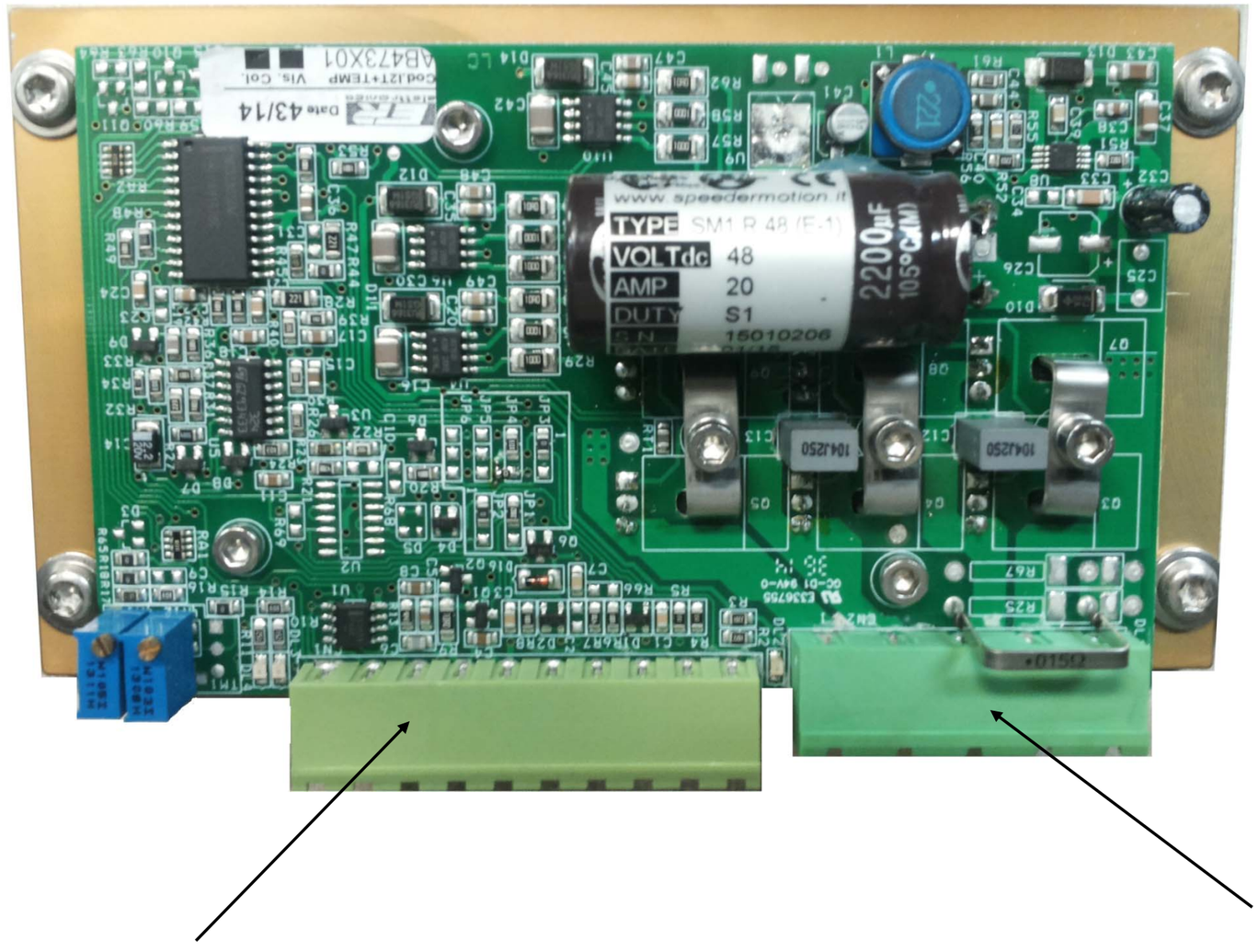
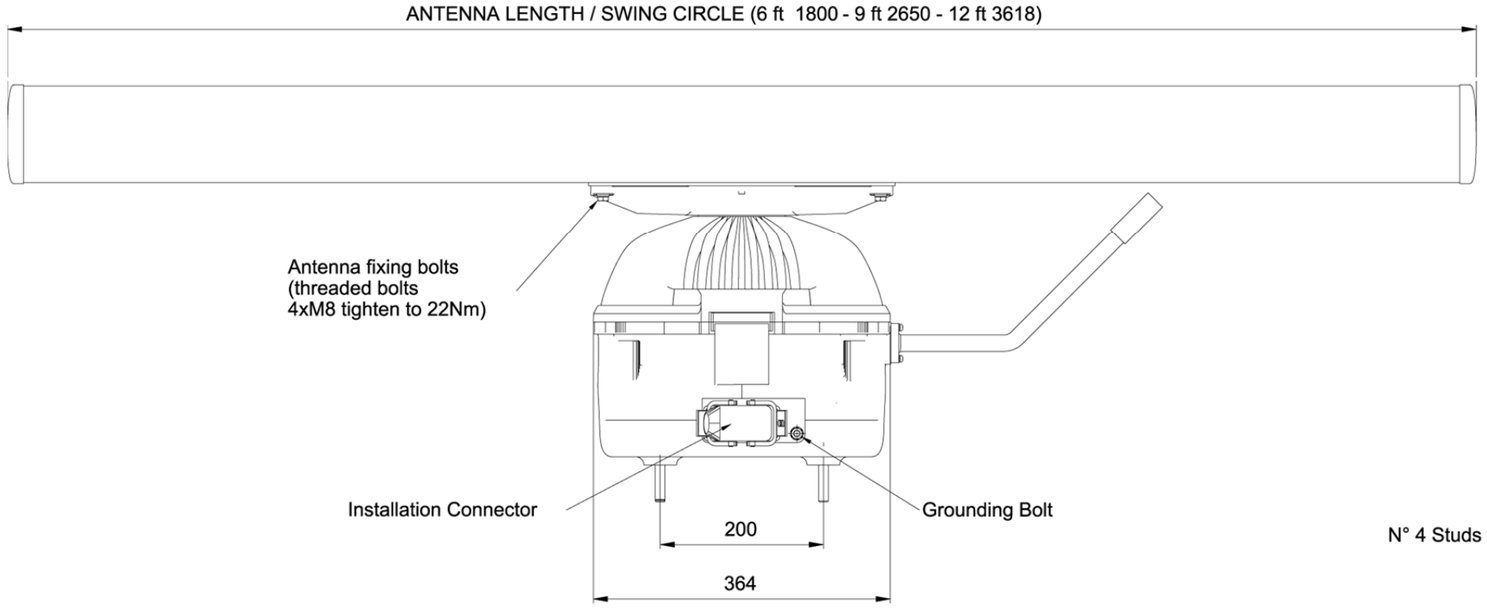
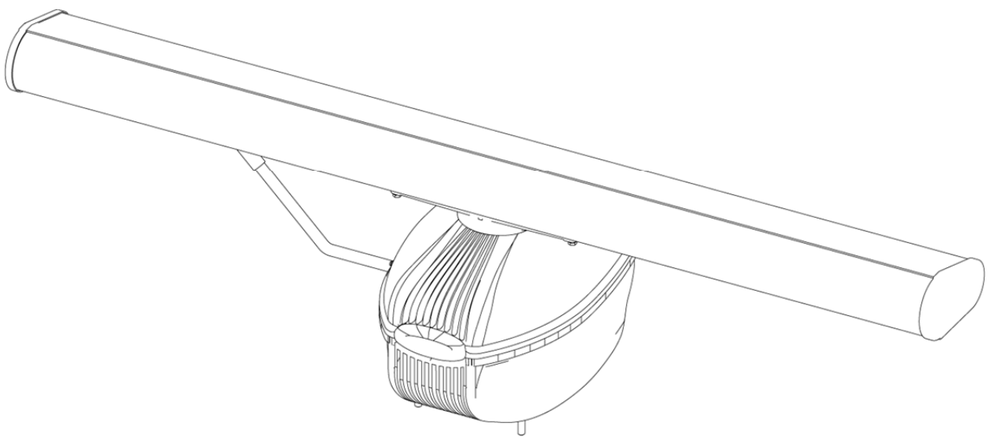
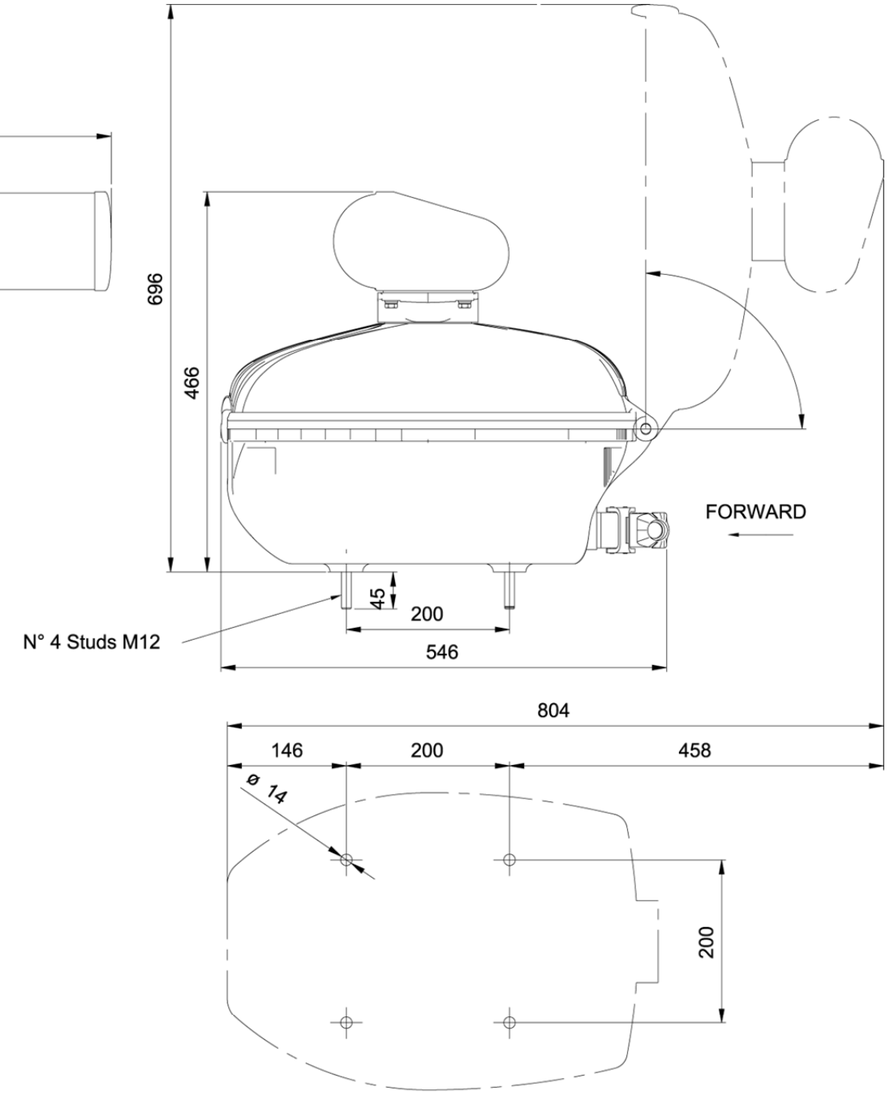


Figure 9.32 – Brushless motor controller







UNIT	IP	WEIGHT
SRT & Antenna 6 Ft	66	40Kg
SRT & Antenna 9 Ft	66	44Kg
SRT & Antenna 12 Ft	66	49Kg

Figure 9.33 – SRT X-BAND RADAR SYSTEM layout

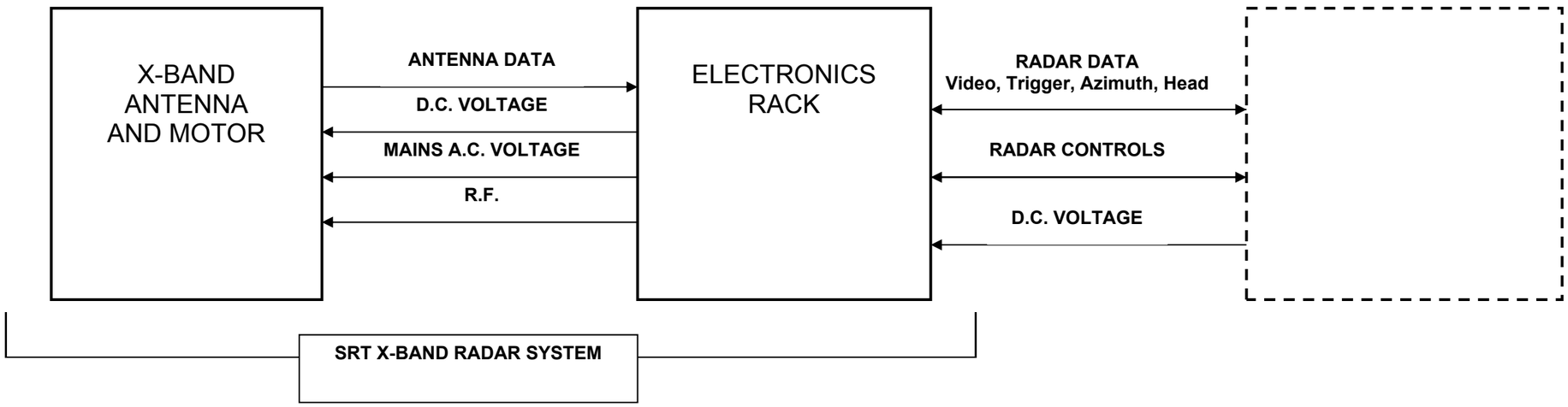


Figure 9.34 – SRT X-BAND RADAR SYSTEM schematic block

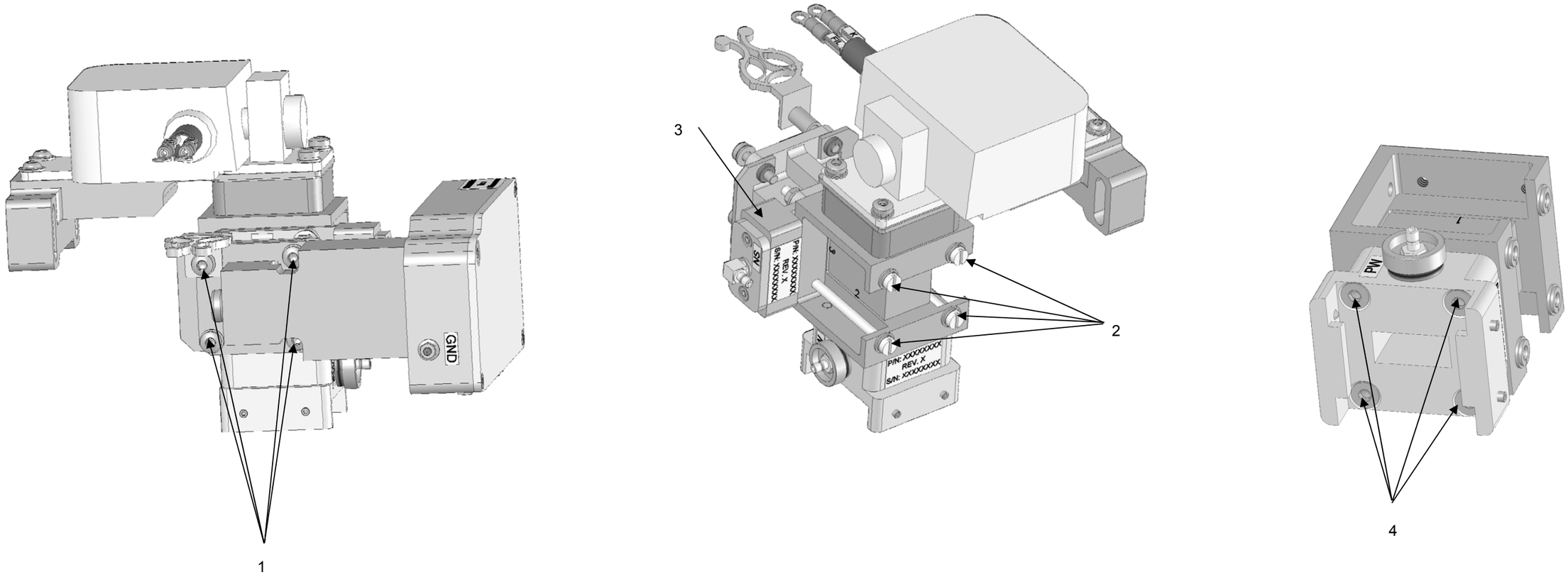


Figure 9.35 – RF amplifier, limiter, noise and power diode and circulator

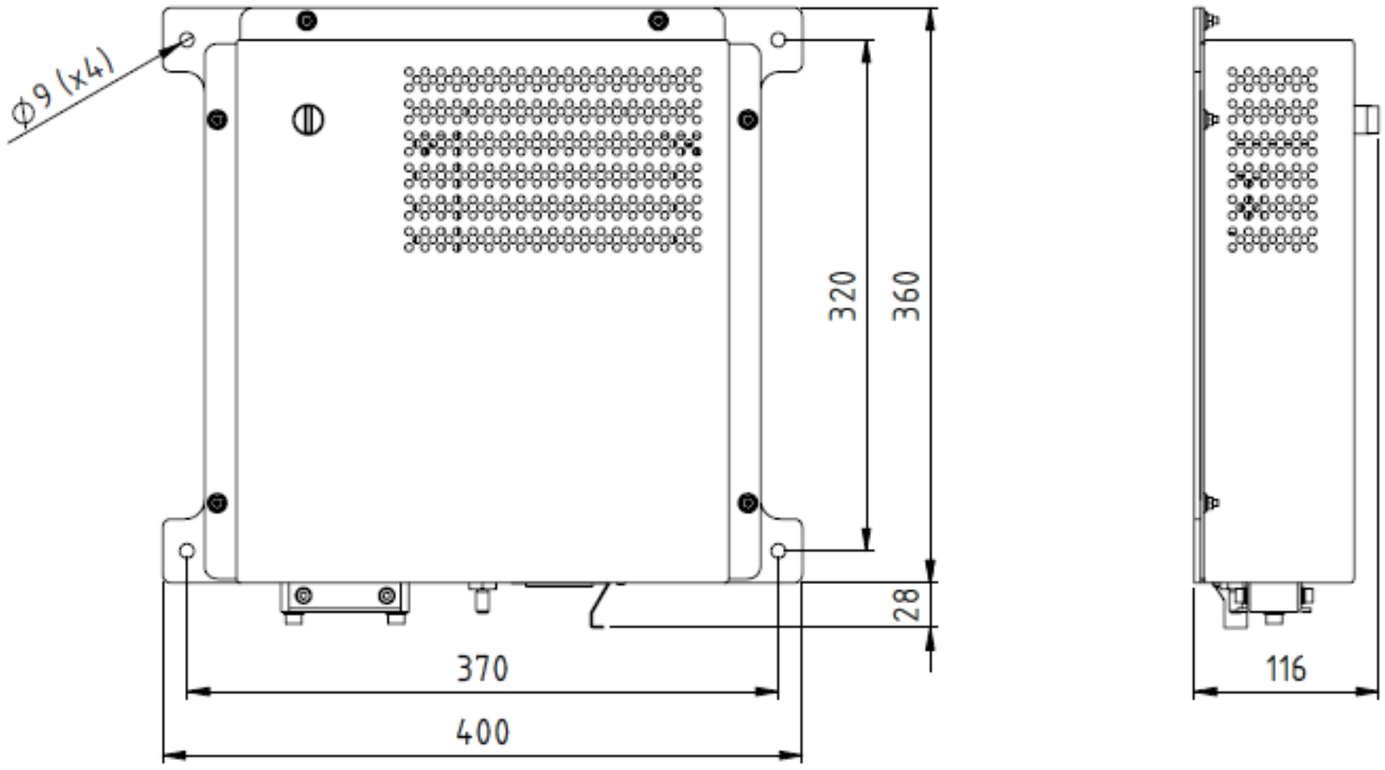


Figure 9.36 – SRT ADAPTER BOX external view

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